

PROJECT MANUAL

Divisions 00-28

Steamboat Base Village Redevelopment

2305 Mount Warner Circle
Steamboat Springs, Co. 80487

**BP3 – GOLDWALK, PREMENADE PERMIT & ISSUE FOR CONSTRUCTION
MAY 19, 2021**

Project Number: 003.7835.000

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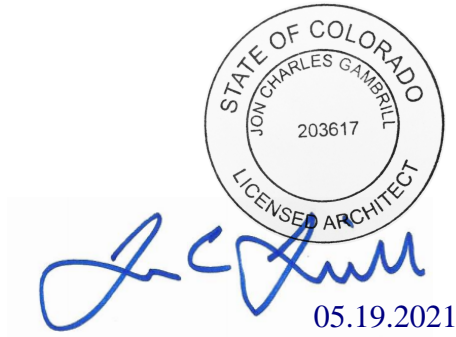
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2021-0519
BP3- Goldwalk and Promenade
Issue for Permit and Construction

**Steamboat Base Village
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**Steamboat Base Village
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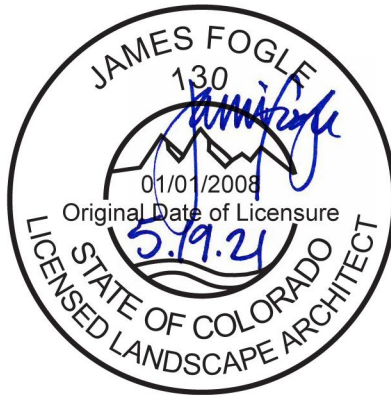
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LANDSCAPE ARCHITECT

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May 19, 2021

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Issue for Permit and Construction

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05/18/2021

Division 21, 22, & 23
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SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Project information.
 2. Work covered by Contract Documents.
 3. Work by Owner.
 4. Work under separate contracts.
 5. Specification and drawing conventions.
 6. Miscellaneous provisions.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to the Work of all Sections in the Specifications. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all.
- B. Conflicts or discrepancies among the Contract Documents shall be resolved in the following order of priority:
1. Contract modifications (such as Change Orders and Bulletins) of later date take precedence over those of earlier date.
 2. the Agreement;
 3. Addenda of later date take precedence over those of earlier date;
 4. the Supplementary Conditions;
 5. The General Conditions;
 6. Drawings and Specifications; Drawings govern Specifications for quantity and location. Specifications govern Drawings for quality and performance. In the event of ambiguity or conflicts, the greater quantity and the better quality shall govern.

1.3 PROJECT INFORMATION

- A. Project Identification: Steamboat Base Village Redevelopment- Goldwalk and Promenade Building - issue for permit and construction - phase I .
1. Project Location: 2305 Mount Werner Circle, Steamboat Springs, CO. 80487 .
- B. Owner: Alterra Mountain Company Real Estate Development .

1. Owner's Representative: Mike Schmidt, Vice President of Development, MSchmidt@alterramtnco.com, 303.749.8262.
 2. Owner Representative: Gregg Riker, Rikon Management, rikonutah@gmail.com, 801.428.7672
- C. Architect: Jon Gambrill, Principal In Charge, jon_gambrill@gensler.com, 303.595.8585.
1. Landscape Architect: Design Workshop, Becky Zimmerman, President, bzimmerman@designworkshop.com, 303.625.5186
 2. Civil Engineer: Landmark Consultants, Erick Griepentrog, PE,erikg@landmark-co.com, 970.846.2592
 3. Structural Engineer: Martin/Martin Engineers, Kelly Knowles, Principal. kknowles@martinmartin.com, 303.431-6100 x5145
 4. Mechanical, Electrical, Plumbing, ME Engineers, Matt Edwards, Assoc. Principal. Matt.Edwards@me-engineers.com, 720. 898-3164
- a.
- D. Project Web Site: A project Web site administered by Contractor will be used for purposes of managing communication and documents during the construction stage.
1. See Section 01 31 00 "Project Management and Coordination" for requirements for establishing, administering and using the Project Web site.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of new construction and renovation of the Steamboat Base Village. The work is to be done in 2 phases. Phase I includes a new outdoor plaza with ice rink and planters. A new entry walk from the transit drop off on Warner Dr to the plaza. This walk is called the Goldwalk. A new escalator, stair and canopy connects the Goldwalk to the Plaza. At the Gondola Sq building the existing Building B is to be demolished. The existing Lower Gondola Terminal Building is also to be demolished, in its place, a new plaza with ice rink and planters will be built. Below the plaza a new building will be built, the Promenade Building, This building will house services for skiers and support spaces. There is Interiors work as well. This work is to be permitted and built separately. The work is to include the Kids Vacation Club (KVC) in the first level of the existing Sheraton hotel. In the Gondola sq. building, the interiors of Building A, C, E, and F will be redone.

- B. The work for the Goldwalk project includes a new entry walk ,referred to as the Goldwalk. The walk extends from the western edge of the Gondola Square Building to the Gondola Square plaza. The work includes the construction of a new escalator and stair connection to the Gondola Square plaza and overhead canopy. The walkway will be lifted up to align with the adjacent entries. New paving and an art wall feature with new lighting and drainage is also included.
- C. Infrastructure to support this project and the concurrent Promenade Building Project is also included in the Goldwalk Package. At the level below the Goldwalk a New Boiler room suppling hot water to the complex's 4 pipe system and for the snow melt system at the plaza and Goldwalk is being constructed.
- D. The work for the Promenade building and Plaza building will be permitted in 3 packages. A Certificate of Occupancy is not being requested until the final package is permitted, constructed, and all life safety systems and inspections and other requirements of the Authorities Having Jurisdiction are completed and approved.
- E. Package I: Promenade Building Shell and Core. This includes foundations, superstructure, and underground utilities. Plaza landscaping Ó hardscape and softscape, ice rink, and stage. Mechanical, electrical, plumbing, fire protection, and Information technology scopes include equipment, distribution systems for the shell and core building and including the refrigeration plant and piping for the ice rink. Architectural scope includes new partitions, finishes, doors and hardware, waterproofing, and exterior enclosure. No vertical transportation Ó elevators and stairs are included.
- F. Package II Ó Promenade Building Ó Tenant interiors: this work includes new partitions, finishes, mechanical, electrical, plumbing, and fire protection for programmed space in the previous shell and core future space.
- G. Package III Ó Promenade Plaza Building Ó Permit and Construction. This work includes the construction of a Food and Beverage Hall on the Plaza level. All architectural systems for completing the Promenade- Plaza building as one building will be part of this package. this scope includes exterior enclosure, interior finishes, exterior upper level patio, partitions, and food service equipment. The Plaza Building package will include vertical transportation Ó elevator Ó connecting the Promenade building to the upper floors of the Plaza Building, and the egress stair from the Promenade Building to the Plaza building Ó thus completing this egress path.
- H. For the MEP systems, the following will be included in each package:
 - 1. Package I:
 - a. Energy Recovery Ventilator (ERV) serving the Promenade building
 - b. Energy Recovery Ventilator (ERV) serving the Plaza building
 - c. Ductwork mains and equipment located within the shell and core finished areas.

- d. Fan coil units, terminal heating, etc. located within the shell and core finished areas.
- e. Main water entry serving Promenade and Plaza Buildings.
- f. Main sanitary, storm, and natural gas serving Promenade and Plaza Buildings.
- g. Main electrical service for Promenade and Plaza Buildings.
- h. Electrical power distribution and lighting for shell and core finished areas.
- i. All life safety systems including fire protection, fire alarm, and egress lighting for shell and core finished areas.

2. Package II

- a. Fan coil units, terminal heating, etc. located within tenant interiors areas of the Promenade building.
- b. Electrical power distribution and lighting for tenant interiors areas.
- c. All life safety systems including fire protection, fire alarm, and egress lighting for tenant interiors areas.

3. Package III

- a. Riser ductwork and louvers serving the Promenade ERV.
- b. Riser ductwork and louvers serving the Plaza ERV.
- c. Ductwork mains, fan coil units, terminal heating, etc. serving the Plaza building.
- d. Electrical power distribution and lighting for the Plaza building.
- e. All life safety systems including fire protection, fire alarm, and egress lighting for the Plaza building.
- f. All kitchen equipment and supporting systems for kitchens located within the Plaza building.

I.

J. Sustainability Initiatives

- 1. Project is designed to comply with the U.S. Green Building Council's "Leadership in Energy & Environmental Design (LEED) Rating System" Certification level as specified in Section 01 81 13 "Sustainable Design Requirements."

K. Type of Contract:

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

1.5 WORK BY OWNER

- 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. Salvage of all items that owner deems valuable prior to contractors starting work.
 - 2. Gondola assembly shall be removed prior to demolition of the Lower Gondola Building.

1.6 WORK UNDER SEPARATE CONTRACTS

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.
- B. Preceding Work: Owner will award separate contract(s) for the following construction operations at Project site. Those operations are scheduled to be substantially complete before work under this Contract begins.
 - 1. BP1A- Escalator procurement package
 - 2. BP1B- IT enabling project.
 - 3. BP2A- Lower Gondola Terminal, Building B, and Stage demolition.

1.7 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. 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 13 00 - DELEGATED DESIGN REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Administrative and procedural requirements for portions of the Work the design of which is delegated to the Contractor.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AHJ: Authority Having Jurisdiction.
- B. Definitions:
 - 1. Delegated: Means transferred by the Architect to the Contractor.
 - 2. Design: Means the complete planning, arrangement, and coordination of a discrete portion of the work, along with its graphic and written communication, including determination and engineering of its organization and structure in response to aesthetic requirements, functional requirements, dimensional and geometric limits, and the arrangement, performance, and other criterion indicated in the Contract Documents.
 - 3. Engineering Services: Means structural engineering services performed for the design, fabrication, and installation of systems, assemblies, and components similar in material, design, complexity and extent to that indicated for the delegated design portion of the Work.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Portions of the Contract Documents may delegate the design of discrete portions of the Work to the Contractor, or may otherwise specify "delegated design requirements" in individual specification Sections.
- B. The Contractor is professionally liable for delegated design work, including design, engineering, and conformance to specified performance requirements.
- C. Drawings of delegated design portions of the Work are diagrammatic; they do not identify or imply solutions to engineering aspects of the portions of the Work that are required to be designed by the Contractor, and are intended to only indicate:
 - 1. The design intent of final profiles, shapes and forms of the specified materials;
 - 2. Relationships between adjacent components of the Work;

3. Location, identification, dimension and size of components, assemblies, accessories, and other components of the Work; and
 4. Schematic joining and attachment details and diagrams of fasteners and connections.
- D. Specifications for delegated design portions of the Work are performance based, and establish the minimum qualities and performance criteria for materials, fabrications, products, systems, assemblies, and methods of execution.
- E. The Architect reviews and determines whether or not the Contractor's proposed delegated designed work:
1. Conform to the design intent of the delegated design portion of the Work being reviewed;
 2. Conform to the specified graphic and specification requirements, including subsequent modifications; and
 3. Is appropriately integrated into the adjacent components of the Work and, where applicable, the overall design of the project.
- F. In the event of a dispute regarding the Contractor's proposed delegated design solutions and the design intent of the Contract Documents, the decision of the Architect is final.

1.4 PROCEDURAL REQUIREMENTS

- A. Design Requirements: Proposed delegated design solutions shall demonstrate conformance to the original design intent of the Contract Documents, as determined by the Architect.
1. Unless otherwise defined by the Contract Documents, the appearance of exposed elements, including member sizes, profiles, and alignment of components shall be within the dimensional limits and section profiles indicated, and consistent throughout the Project where the delegated design component of the Work is to be installed.
 2. Deviation from the profiles, layouts, dimensional locations, or arrangements indicated is not permitted without prior written consent from the Architect.
 3. Deviations from the specifications are not permitted without prior written consent from the Architect.
 4. Contractor-proposed delegated design solutions that exactly follow the details indicated on the Drawings do not relieve the Contractor from liability for the design, fabrication, and performance of the delegated design portions of the Work.
- B. Engineering Requirements: Engineer delegated design portions of the Work shall;
1. Meet or exceed the specified performance performance and quality requirements;
 2. Conform to the dimensional and graphic requirements of the Drawings;
 3. Satisfy the requirements of the AHJ; and
 4. Provide structurally sound, leak-proof, non-corroding, and weather tight assemblies, as applicable, that accommodate, resist, distribute, or transfer, as applicable, the minimum specified in-service loads, and thermal, seismic, and wind sway, or other types of movement, without incipient or catastrophic failure.

- C. Regulatory Requirements: Delegated design items shall be engineered in conformance with the International Building Code and Routt County Amendments.

1.5 SUBMITTALS

- A. General: Coordinate and process submittals for delegated design portions of Work in same manner as for other portions of Work.
- B. Professional Engineer's qualifications.
- C. Design Data: Submit structural engineering calculations demonstrating conformance to the requirements of the Contract Documents and of the AHJ.
 - 1. Calculations must be legible and incorporate sufficient cross-references to shop drawings to make calculations readily understandable and reviewable.
 - 2. At a minimum, structural calculations must contain:
 - a. An analysis of framing members;
 - b. Section property computations for framing members;
 - c. An analysis of anchors, including anchors embedded in concrete; and
 - d. The signature and seal of the professional structural engineer, licensed in the state of Co. , and responsible for their preparation.
 - 3. Test reports are not an acceptable substitute for calculations.

1.6 QUALITY ASSURANCE

- A. Professional Structural Engineer's Qualifications: Must be legally licensed or otherwise qualified to practice in the state of Co. . The engineer shall have not less than 10 consecutive years' experience providing engineering services for delegated design work similar in material, design, complexity, and extent to this Project, as determined by the Architect, and whose Work products have resulted in installations with a record of successful in-service performance.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide materials, fabrications, products, components, and accessories required for a complete installation, whether or not such items are indicated on the Drawings or in the Specifications.

- B. Provide anchors, attachments, inserts, fasteners, clips, bracing, framework, and similar items as required to meet specified design and performance requirements, and to securely attach delegated design Work to adjacent supports, or to adjoining work, whether or not such items are indicated on the Drawings or in the Specifications.

PART 3 - EXECUTION

3.1 DESIGN

- A. Unless otherwise indicated or specified, maintain the design intent and conform to the performance requirements indicated on the Drawings and in the Specifications, as determined by the Architect.
 - 1. In the interest of fabrication or erection methods, minor dimensional changes and detailing adjustments to the original design communicated in the Contract Documents may become necessary.
 - 2. Obtain written approval from the Architect for proposed changes and adjustments before procurement, fabrication, manufacture, assembly, or installation, as applicable.
- B. Engage a qualified professional structural engineer to design connection details and determine fastener types and sizes.
 - 1. Fasteners or connections may neither conflict with nor require revision to the finish profiles indicated or the supporting work.
 - 2. Connections may not impose eccentric loading, nor induce twisting or warping to the supporting structure.
 - 3. Connections must be designed to accommodate potential and actual misalignment of adjacent work within tolerances specified in other Sections.

3.2 DELEGATED DESIGN SCHEDULE

- A. Section 04 42 00 "Exterior Stone Cladding," for the support system stone cladding.
- B. Section 05 40 00 "Cold-Formed Metal Framing," for load-bearing and exterior non-load-bearing metal stud framing.
- C. Section 05 50 00 "Metal Fabrications," for metal items made from iron and steel, stainless steel, and non-ferrous metal shapes.
- D. Section 05 51 13 "Metal Stairs," for steel stairs with pan and/or plate treads.
- E. Section 05 52 13 "Pipe and Tube Railings," for railings fabricated from aluminum, stainless steel, and steel pipe and tubing.

- F. Section 05 73 00 "Decorative Metal Railings," for ornamental metal and glass railing systems fabricated from stock metal shapes.
- G. Section 08 44 13 "Glazed Aluminum Curtain Walls," for stock aluminum curtain wall systems.
- H. Section 08 81 00 "Glazing," for all glazing.
- I. Section 09 22 16 "Non-Structural Metal Framing," for light gauge metal framing of gypsum board, gypsum plaster, and portland cement plaster partitions and ceilings.

END OF SECTION 01 13 00

SECTION 01 14 00 - WORK RESTRICTIONS

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. Existing utility interruptions.
 - 2. Use of premises.
 - 3. Occupancy requirements during construction.
 - 4. Occupancy requirements prior to Substantial Completion.
 - 5. Miscellaneous restrictions.

1.3 EXISTING UTILITY INTERRUPTIONS

- A. 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 5 days in advance of proposed utility interruptions.
 - 2. Obtain Owner's written permission before proceeding with utility interruptions.

1.4 USE OF PREMISES

- A. Access: At all times, provide the Architect and the Owner's representatives, easy and safe access to the Work wherever it is in preparation and progress. Provide such access so Architect may perform its functions. Provide access to any testing agencies to perform required testing.
- B. Property Manager's Rules: Conform at all times to the Owner's requirements for protection of plant, materials, equipment, and noise levels. A copy of the Owner's rules will be furnished from the Owner upon written request.

- C. Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
- D. Use of Site: Confine operations at the site to areas permitted by law, ordinances, permits, and the Contract Documents. Do not unreasonably encumber the Site with any materials or equipment. Coordinate loading on floor or roof with Architect and/or Structural Engineer to assure that no surfaces exceed carrying capacity.
 - 1. Coordinate with Owner for secured storage within the building, if applicable.
 - 2. Protect and maintain common areas of the building that are in the path of travel for construction personnel and used for transporting materials and equipment to and from the construction site.
 - 3. Limits: Confine constructions operations to Contract Limits.
 - a. Limit site disturbance, including earthwork and clearing of vegetation, to 40 feet beyond building perimeter; 10 feet beyond surface walkways, patios, surface parking, and utilities; less than 12 inches in diameter; 15 feet beyond primary roadway curbs and main utility branch trenches; and 25 feet beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities, and playing fields) that require staging areas in order to limit compaction in the constructed area.
 - 4. Driveways and Entrances: Keep driveways, parking lots, 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 storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
 - 5. Do not block entrances, fire exits or lanes, or delivery routes.
 - 6. Limit use of driveways and entrances to the following times:
 - a. Work hours as defined by Owner.
- E. On-Site Work Hours: Limit work in the existing building to normal business working hours, Monday through Friday, as defined by Owner, unless otherwise indicated.
 - 1. Hours for Noise-Generating, Odor-Generating, and Dust-Generating Activities and Demolition: After business hours, or at such times as approved by the Owner.

- a. Noise- and Odor-Generating activities include, but are not limited to, sprinkler work, concrete saw cutting, core drilling, spray painting, hammering, nailing, and similar work, which may cause noise, dust, or odors, thereby disturbing occupants.
- F. Condition in Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations. Protect building and its occupants during construction period.

1.5 OCCUPANCY REQUIREMENTS DURING CONSTRUCTION

- A. 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 approval of authorities having jurisdiction.
 - 2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.
 - 3. Schedule use of premises for Work and coordinate construction operations with the Owner to allow for Owner occupancy.
 - 4. Schedule use of premises for Work and coordinate construction operations with the Owner to allow for use of site and premises by the public.
 - 5. Keep premises orderly, clean and with a minimum of obstruction and inconvenience to the tenants and the public.
 - 6. Relocate any stored products that interfere with public access, operations of the Owner or separate contractor. If necessary, obtain and pay for additional storage or work areas needed for operations.

1.6 OCCUPANCY REQUIREMENTS PRIOR TO SUBSTANTIAL COMPLETION

- A. 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 partial 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 Owner acceptance of the completed Work.
2. Obtain a Certificate of Occupancy from authorities having jurisdiction before 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 provide, 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.

1.7 MISCELLANEOUS RESTRICTIONS

- A. 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 5 days in advance of proposed disruptive operations.
 2. Obtain Owner's written permission before proceeding with disruptive operations.
- B. Controlled Substances: Use of tobacco products and other controlled substances within the existing building on Project site is not permitted.
- C. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.
- D. 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.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 14 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 Sections:
 - 1. Section 01 60 00 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.
 - 2. Divisions 02 through 49 Sections for specific requirements and limitations for substitutions.

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 "Substitution Request" form provided in Document 00 60 00 "Forms."

2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication, or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES and local regulations.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 10 working 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 Bulletin 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 qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

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

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately upon 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. Requested substitution provides sustainable design characteristics that specified product provided .
 - c. Substitution request is fully documented and properly submitted.
 - d. Requested substitution will not adversely affect Contractor's construction schedule.
 - e. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - f. Requested substitution is compatible with other portions of the Work.
 - g. Requested substitution has been coordinated with other portions of the Work.
 - h. Requested substitution provides specified warranty.
 - i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Not allowed, unless otherwise indicated.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 25 00

SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
 - 1. Section 01 25 00 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

1.3 MINOR CHANGES IN THE WORK

- A. Architect may issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on "Bulletin" form included in Document 00 60 00 "Forms."

1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Bulletins with "Architect's Request for Contractor's Proposal" indicated, issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
 - 2. Within time specified in Bulletin after receipt of Bulletin, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

- b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 - e. Quotation Form: Use forms acceptable to Architect.
- B. Contractor-Initiated Proposals (Change Order Request): If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.
 - 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
 - 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - 4. Include costs of labor and supervision directly attributable to the change.
 - 5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 - 6. Comply with requirements in Section 01 25 00 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
 - 7. Proposal Request Form: Use form acceptable to Architect.

1.5 CHANGE ORDER PROCEDURES

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

1.6 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 26 00

SECTION 01 29 00 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Sections include the following:
 - 1. Section 01 26 00 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 2. Section 01 32 00 "Construction Progress Documentation" for administrative requirements governing preparation and submittal of Contractor's Construction Schedule.

1.3 DEFINITIONS

- A. Site Visit: Architect's visits to the site at intervals necessary in the judgment of Architect to become generally familiar with the progress and quality of the Work completed and to determine in general if the Work completed is in accordance with the Contract Documents. Architect will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work.
- B. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
 - 1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:

- a. Application for Payment forms with Continuation Sheets.
 - b. Submittals Schedule.
 - c. Items required to be indicated as separate activities in Contractor's Construction Schedule.
 2. Submit the Schedule of Values to Architect at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
 3. Sub schedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide sub schedules showing values correlated with each phase of payment.
 4. Sub schedules for Separate Elements of Work: Where the Contractor's construction schedule defines separate elements of the Work, provide sub schedules showing values correlated with each element.
- B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one-line item for each Specification Section.
1. Identification: Include the following Project identification on the Schedule of Values:
 - a. Project name and location.
 - b. Name of Architect.
 - c. Architect's project number.
 - d. Project Manager's name and address.
 - e. Contractor's name and address.
 - f. Date of submittal.
 2. Arrange schedule of values consistent with format of AIA Document G703.
 3. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
 - 1) Labor.
 - 2) Materials.

- 3) Equipment.
4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of Contract Sum. Break down principal subcontract amounts into separate labor and materials items. Breakdown of subcontractor's schedule of values must be true and accurate.
5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
6. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site. Include evidence of insurance or bonded warehousing if required.
7. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
8. Include separate line items under Contractor and principal subcontracts Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
9. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
10. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: The date of each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

- C. Payment Application Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
 - 1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
 - 2. Include amounts of work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
 - 3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
 - 4. Indicate separate amounts for work being carried out under Owner-requested project acceleration, if any.
- E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and off-site.
 - 1. Provide description of item(s) being stored.
 - 2. Location of the bonded warehouse(s) where materials or equipment is stored.
 - 3. Bill of sale made to Owner stating there will be no additional cost for transportation and delivery of the stored item(s).
 - 4. Statement certifying that item, or any part thereof will not be installed in any construction other than Work under this Contract.
 - 5. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
 - 6. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 - 7. Provide summary documentation for stored materials indicating the following:
 - a. Materials previously stored and included in previous Applications for Payment.
 - b. Work completed for this Application utilizing previously stored materials.
 - c. Additional materials stored with this Application.
 - d. Total materials remaining stored, including materials with this application.
- F. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
 - 1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

- G. **Waivers of Mechanic's Lien:** With each Application for Payment, submit notarized waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
1. Submit partial waivers on each item for amount requested, before deduction for retainage, on each item.
 2. When an application shows completion of an item, submit final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. Submit final Application for Payment with or preceded by final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
 5. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.
- H. **Initial Application for Payment:** Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors, principal suppliers and fabricators.
 2. Schedule of Values.
 3. Combined Contractor's construction schedule (preliminary if not final) incorporating Work of multiple contracts, with indication of acceptance of schedule by each Contractor.
 4. Products list (preliminary if not final).
 5. Submittals Schedule (preliminary if not final).
 6. List of Contractor's staff assignments.
 7. List of Contractor's principal consultants.
 8. Copies of building permits.
 9. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 10. Initial progress report.
 11. Report of preconstruction conference.
 12. Certificates of insurance and insurance policies.
 13. Performance and payment bonds.
 14. Data needed to acquire Owner's insurance.
 15. Initial settlement survey and damage report if required.
 16. Construction waste management program.
- I. **Application for Payment at Substantial Completion:** After issuance of the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.

2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- J. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
 1. Evidence of completion of Project closeout requirements, including, but not limited to:
 - a. Transmittal of required Project Record Documents to Owner.
 - b. Evidence of completion of demonstration and training.
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 3. Updated final statement, accounting for final changes to the Contract Sum.
 4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
 5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
 6. AIA Document G707, "Consent of Surety to Final Payment."
 7. Evidence that claims have been settled.
 8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
 9. Final liquidated damages settlement statement.
 10. Occupancy permits and similar approvals or certifications by governing authorities and franchised services, assuring Owner's full access and use of completed work.

1.6 REVIEW OF APPLICATION FOR PAYMENT

- A. Draft Copy: Submit draft (pencil) copy of the Application for Payment ten days prior to due date for review by Architect.
- B. Upon receipt of the official Application for Payment and other documentation as required by the Architect, including the updated Schedule of Values and the updated Contractor's Construction Schedule if required, the Architect shall review the documents received to determine if they correspond to the agreements reached during the draft copy review meeting.
- C. The Architect will rely on the accuracy and completeness of the information furnished by the Contractor. Issuance of a Certificate of Payment will not be deemed to represent that the Architect performed audits of the supporting data.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

PAYMENT PROCEDURES

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.
- B. Related Sections
 - 1. Section 23 05 01 / 26 05 01 "Mechanical Electrical Coordination" for additional requirements for coordination drawings and procedures.

1.2 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General project coordination procedures.
 - 2. Coordination Drawings.
 - 3. Project Web site.
 - 4. Administrative and supervisory personnel.
 - 5. Project meetings.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Section 01 32 00 "Construction Progress Documentation" for preparing and submitting the 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 Contract closeout.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities or as specified in individual Sections.
 - 1. Indicate relationship of components shown on separate Shop Drawings.

2. Indicate required installation sequences.
- B. 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. Use CSI Form 1.5A in Document 00 60 00 "Forms." Include the following information in tabular form:
1. Name, address, and telephone number of entities 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.
- C. 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 telephone numbers, including home, office, 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, on Project Web site, and by each temporary telephone. Keep list current at all times.

1.4 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in various 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.
 4. Arrange pipes, ducts, conduits, and other overhead systems in an orderly manner when indicated to remain exposed.
- B. If necessary, 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.

- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's Construction Schedule.
 2. Preparation of the Schedule of Values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.

1.5 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one 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 the 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 the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate 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 ceiling plenum to accommodate layout of light fixtures 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 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 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 changes as directed 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 Submittal Format: Submit or post coordination drawing files using format same as file preparation format.
 3. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
 - a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
 - b. Digital data files will be provided in the software and format that is used to prepare the Contract Documents. Translations to different programs or modifications to the drawing setup will be the responsibility of the Contractor.
 - c. Contractor shall execute a data licensing agreement in using the "Gensler Data Transfer Agreement".

1.6 PROJECT WEB SITE

- A. The Contractor shall provide, administer, and use a 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. Task and issue management.
 7. Photo documentation.
 8. Schedule and calendar management.
 9. Submittals forms and logs.
 10. Payment application forms.
 11. Drawing and specification document hosting, viewing, and updating.
 12. Online document collaboration.
 13. Reminder and tracking functions.
 14. Archiving Function
- B. Provide Project Web site user licenses for use of the Owner, Owner's Commissioning Authority, Architect, and Architect's consultants. Provide eight hours of software training online for Project Web site users.
- C. On completion of Project, provide one complete archive copy of Project Web site files to Owner and to Architect in a digital storage format acceptable to Architect.
- D. Provide one of the following Project Web site software packages under their current published licensing agreements:
1. Autodesk, BIM 360 Docs.
 2. Procore Technologies.
 3. Contractor specific web site software that meets the listed requirements.
- E. Contractor, subcontractors, and other parties granted access by Contractor to Project Web site shall execute a data licensing agreement in the form of Agreement acceptable to Owner and Architect.

1.7 PROJECT MEETINGS

- A. General: General Contractor will 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.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
 4. Notification: Inform participants three days prior to meetings not regularly scheduled.

- B. Preconstruction Conference: a preconstruction conference before starting construction, at a time convenient to Owner, Construction Manager, if one is retained by 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; manufacturers; suppliers; testing laboratory representatives; and other concerned parties shall attend the conference. All 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. Requirements in individual Specification Sections for preconstruction responsibilities.
 - b. Tentative construction schedule.
 - c. Project coordination
 - d. Critical work sequencing and long-lead items.
 - e. Designation of key personnel and their duties.
 - f. Lines of communication.
 - g. Procedures for processing Requests for Interpretation (RFIs.)
 - h. Procedures for processing Bulletins.
 - i. Procedures for processing submittals.
 - j. Procedures for processing substitution requests.
 - k. Procedures for processing field decisions, proposal requests and Change Orders.
 - l. Procedures for testing and inspecting.
 - m. Procedures for processing Applications for Payment.
 - n. Distribution of the Contract Documents.
 - o. Preparation of Record Documents.
 - p. Use of the premises and existing building.
 - q. Work restrictions.
 - r. Working hours.
 - s. Owner's occupancy requirements.
 - t. Responsibility for temporary facilities and controls.
 - u. Procedures for moisture and mold control.
 - v. Procedures for disruptions and shutdowns.
 - w. Construction waste management and recycling.
 - 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. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires 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 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 RFI.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility requirements.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written instructions.
 - n. Warranty requirements.
 - o. Compatibility of materials.
 - p. Acceptability of substrates.
 - q. Temporary facilities and controls.
 - r. Space and access limitations.
 - s. Regulations of authorities having jurisdiction.
 - t. Testing and inspecting requirements.
 - u. Installation procedures.
 - v. Coordination with other work.
 - w. Required performance results.
 - x. Protection of adjacent work.
 - y. Protection of construction and personnel.
 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.

5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: a project closeout conference, at a time convenient to Owner and Architect, but no later than 30 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 preparing operations and maintenance data.
 - e. Requirements for delivery of material samples, attic stock, and spare parts.
 - f. Requirements for demonstration and training.
 - g. Preparation of Contractor's punch list.
 - h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - i. Submittal procedures for closeout documents.
 - j. Owner's partial occupancy requirements.
 - k. Installation of Owner's furniture, fixtures, and equipment.
 - l. Responsibility for removing temporary facilities and controls.
- E. Progress Meetings: progress meetings at weekly 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 conference 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) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site utilization.
 - 9) Temporary facilities and controls.
 - 10) Work hours.
 - 11) Hazards and risks.
 - 12) Progress cleaning.
 - 13) Quality and work standards.
 - 14) Pending changes
 - 15) Status of Change Orders.
 - 16) Pending claims and disputes.
 - 17) Documentation of information for payment requests.
 - 18) Testing and inspection requirements.
 - 19) Status of Request for Information.
 - 20) Other business relating to the Work.
4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report.
- 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.

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BP3-Goldwalk, Promenade-
Permit and IFC

**Steamboat Base Village
Redevelopment**
Steamboat Springs, Colorado

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. Contractor's construction schedule.
 - 2. Daily construction reports.
 - 3. Material location reports.
 - 4. Site condition reports.
 - 5. Special reports.
- B. Related Sections include the following:
 - 1. Section 01 29 00 "Payment Procedures" for submitting the Schedule of Values.
 - 2. Section 01 31 00 "Project Management and Coordination" for submitting and distributing meeting and conference minutes.
 - 3. Section 01 33 00 "Submittal Procedures" for submitting schedules and reports.
 - 4. Section 01 40 00 "Quality Requirements" for submitting a schedule of tests and inspections.

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 activities are activities on the critical path. They must start and finish on the planned early start and finish times.
 - 2. Predecessor activity is an activity that must be completed before a given activity can be started.
 - 3. Successor Activity: An activity that follows another activity in the network.

- B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by Architect.
- 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 continuous chain of 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 following activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.
- H. Major Area: A story of construction, a separate building, or a similar significant construction element.
- I. Milestone: A key or critical point in time for reference or measurement.
- J. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.
- K. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format, unless indicated otherwise:
 - 1. PDF electronic file.

- B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
- C. Construction Schedule Updating Reports: Submit with each Application for Payment.
- D. Site Condition Reports: Submit at time of discovery of differing conditions.
- E. Special Reports: Submit at time of unusual event.

1.5 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
- B. 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 parties involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.
- C. Coordinate Contractor's construction schedule with Owner's construction schedule for Owner's own forces. Revise Contractor's construction schedule, if necessary, after a joint review and mutual agreement. The construction schedule shall then constitute the schedule to be used by Contractor, separate contractors and Owner until subsequently revised.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established for commencement of the Work to date of Final 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.
- B. 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. 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.
- C. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion
 1. .
- D. 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 RFI.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and Contract Time.
- E. Recovery Schedule: When periodic update indicates the Work is 10 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, and equipment required to achieve compliance, and date by which recovery will be accomplished.
- F. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules. Coordinate with Architect regarding which project management software will be used on the Project.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. Startup Network Diagram: Submit diagram within 14 days of date established for commencement of the Work. Outline significant construction activities for the first 60 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 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 30 days after date established for commencement of the Work.
 - 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, regardless of Architect's approval of the schedule.
 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 in order to coordinate with the Contract Time.
- D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the preliminary 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 commissioning.
 - j. Punch list and final completion.
 - k. 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 or 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.
- 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 list of straight "early start-total float" sort. Identify critical activities. Prepare tabulated reports showing the following:
 1. Contractor or subcontractor and the Work or activity.
 2. Description of activity.
 3. Principal events of activity.
 4. Immediately 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.

2.3 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. Approximate count of personnel at Project site.
 3. Equipment at Project site.
 4. Material deliveries.
 5. High and low temperatures and general weather conditions, including rain or snow accumulation.
 6. Accidents.
 7. Meetings and significant decisions.
 8. Unusual events (refer to special reports).
 9. Stoppages, delays, shortages, and losses.
 10. Meter readings and similar recordings.
 11. Tests and inspections, including name(s) of testing and inspection agency(ies).
 12. Emergency procedures.
 13. Orders and requests of authorities having jurisdiction.
 14. Change Orders received and implemented.
 15. Construction Change Directives received and implemented.
 16. Services connected and disconnected.
 17. Equipment or system tests and startups.
 18. Partial Completions and occupancies.
 19. Substantial Completions authorized.
- B. Material Location Reports: At weekly intervals, prepare 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 a detailed report. Submit with a Request for Interpretation (RFI). Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.4 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

- B. Reporting Unusual Events: 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, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. 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 Actual Completion percentage for each activity.
 4. Notify Owner and Architect a minimum of one week prior to issuance of updated schedule of all anticipated significant revisions to the Construction Schedule.
- B. 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 electronic copies of the updated project schedule on the project website.
 2. Post copies in Project meeting rooms and temporary field offices.
 3. 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.

END OF SECTION 01 32 00

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's and Commissioning Agent'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 and Commissioning Agent'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.

1.3 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or modifications to submittals noted by the 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. 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.
3. 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 dates for installation.
 - i. Activity or event number.
4. Architect reserves the right to withhold 10 percent of each payment request, in addition to retainage fee if any, until the submittal schedule is received and accepted by the Architect.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect's Digital Data Files: Electronic copies of Drawings of the Contract Drawings and Project Manual will not be provided by Architect.
- B. Architect's Digital Data Files: At Contractor's written request, electronic copies of Drawings of the Contract Drawings and Project Manual will be provided by Architect for Contractor's use in preparing submittals and Project record documents.
 1. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 2. Execute and submit the Data Transfer Agreement form included in Document 00 60 00 "Project Forms." Do not distribute digital data drawing files prior to transmitting to Architect copies of Data Transfer Agreement signed by each entity requesting the files.
- C. 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 Action and Informational submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.

- a. Exception: Where samples for initial selection and samples for verification are both required, submit samples for verification after initial selection has been returned by Architect.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- D. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. Architect will document on submittal the date of receipt. Submittals received by Architect after 1:00 p.m. will be considered as received the following working day. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 1. Initial Review: Allow 10 working days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination. Delaying submittals to facilitate coordination between submittals shall not constitute a delay of the Work nor shall it be the basis for an extension of time.
 2. Concurrent Consultant Review: Transmit submittals directly to Architect's consultants, provide duplicate copy of transmittal to Architect. Allow 15 days for initial review of each submittal. Submittal will be returned to Architect before being returned to Contractor. Concurrent review of submittals is limited to the following:
 - a.
 3. If intermediate submittal is necessary, process it in same manner as initial submittal.
 4. Allow 15 days for review of each resubmittal.
- E. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
 1. Assemble complete submittal package into a single indexed file with links enabling navigation to each item.
 - a. Unique identifier, including revision number. Submittals shall be numbered with the Section number, followed by a dash, followed by a three-digit number, followed by a dash, and ending with a sequential submission number as indicated below. The numbering system shall be retained throughout all revisions.

- 1) Section Number: Section number where submittal is specified.
 - 2) Three-Digit Number: Sequential number, beginning with "001," for each submittal transmitted to Architect for each Section.
 - 3) Submission Number: Use "0" for initial submittal, "1" for first resubmittal, "2" for second resubmittal, and so forth.
 - 4) Example: 061000-001-0 (Section 06 10 00, first submission of the Section, initial submittal).
2. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect and Construction Manager.
 3. Scanned Copies: Legible scanned PDF files of paper originals are acceptable. Scanned submittals that are not legible will be rejected.
 4. Sheet Orientation: Orient PDF sheets to a "Ready-to-Read" orientation with majority of text horizontal to the sheet with no additional adjustments or formatting required by the viewer.
 5. File Security: Do not set any permissions on the file. Protected documents will not be accepted.
 6. Transmittal Form for Electronic Submittals: Use software-generated form from electronic project management software.
 7. Metadata: Include the following information in the electronic submittal file metadata:
 - a. Title: Project title
 - b. Author: Contractor's name.
 - c. Subject: Submittal type (product data, shop drawing, report, etc.)
 - d. Keywords: Number and title of appropriate Specification Section; manufacturer name; product name/model number.
 8. File Size: Limit file size of each submittal as follows. Break larger PDF files into multiple packages where necessary to meet delivery restrictions. Identify split packages as "1 of #" and "2 of #" in the subject line.
 - a. Email Delivery: 2 Megabytes.
 - b. FTP Delivery: 100 Megabytes.
- F. Options: Identify options requiring selection by Architect.
- G. Deviations and Additional Information: On an attached separate document, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- H. 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 stamped with Architect's action stamp marked "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED"
4. Costs of compensation for Architect's additional services and expenses made necessary for review of submittals exceeding the limits set forth below shall be at the Contractor's expense.
 - a. Reviews of Each Submittal: Two, including initial review.
- I. 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.
- J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals with Architect's action stamp marked "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS AS NOTED"
- K. The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples or similar submittals until the respective submittal has been reviewed by Architect and returned to Contractor with Architect's action stamp marked "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS AS NOTED"

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 1. Post electronic submittals as PDF electronic files directly to Project Web site specifically established for Project. Do not post zipped files.
 - a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 2. Submit electronic submittals via email as PDF electronic files. Do not post zipped files.
 - a. Architect, through Construction Manager, will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 3. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 01 77 00 "Closeout Procedures."

4. Certificates and Certifications Submittals: Provide 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.
 - a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
 - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.
 5. Systems Submittals: Identify submittals for systems such as fire alarms and fire protection systems, on the transmittal and act upon the system singularly as a combined submittal. If resubmission is required, resubmit entire system submittal,
- B. 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 printed data are not suitable 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 written recommendations.
 - c. Manufacturer's product specifications.
 - d. Standard color charts.
 - e. Mill reports.
 - f. Standard product operating and maintenance manuals.
 - g. Compliance with recognized trade association standards.
 - h. Compliance with recognized testing agency standards.
 - i. Application of testing agency labels and seals.
 - j. Notation of coordination requirements.
 - k. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing 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 or concurrent with Samples.
 6. Submit Product Data in the following format:
 - a. PDF electronic file.

- b. Paper copies.
- C. LEED Submittals: Information required to document LEED credits as defined in other Division 01 Sections and in individual Specification Sections. Include "LEED Criteria Worksheet" in Document 00 60 00 "Forms" for every submittal for the Project.
 - 1. Submit Product Data in the following format:
 - a. PDF electronic file.
- D. Shop Drawings: Prepare and submit Project-specific information, drawn accurately to scale. Do not reproduce, digitally or otherwise, the Contract Documents and submit as Shop Drawings. Do not use, copy or reproduce title blocks, dimensions, notes, keynotes, symbols schedules or details from Contract Drawings, digital or otherwise. Use of the Contract Drawings shall be limited to reproduction, digitally or otherwise, of the exterior wall layout, interior partition layout, grid lines, doors, and windows. Do not base Shop Drawings on standard printed data.
 - 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Fabrication and installation drawings.
 - c. Roughing-in and setting diagrams.
 - d. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - e. Shopwork manufacturing instructions.
 - f. Templates and patterns.
 - g. Schedules.
 - h. Design calculations.
 - i. Compliance with specified standards.
 - j. Notation of coordination requirements.
 - k. Notation of dimensions established by field measurement.
 - l. Relationship and attachment to adjoining construction clearly indicated.
 - m. Seal and signature of professional engineer if specified.
 - 2. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
- E. Samples: Submit physical units of materials or products for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
 - 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.

2. Refer to individual Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
3. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 - e. Specification paragraph number and generic name of each item.
4. Submit corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
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.
 - b. Architect will return submittal with options selected.
7. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from the same material to be used for the Work, cured and finished in manner specified, and physically identical with the 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:
 - 1) Submit three sets of Samples.
 - 2) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.

- 3) Submit at least three sets of paired units that show approximate limits of variations if variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample.
 - b. Architect will retain one Sample set; remainder will be returned. Mark up and retain one returned Sample set as a Project record sample.
 8. Preparation: Mount, display, or package Samples in manner specified to facilitate review of qualities indicated. Prepare Samples to match Architect's sample where so indicated. Attach label on unexposed side that includes the following:
 - a. Generic description of Sample.
 - b. Product name or name of manufacturer.
 - c. Sample source.
 9. Submit Samples for review of kind, color, pattern, and texture for a final check of these characteristics with other elements and for a comparison of these characteristics between final submittal and actual component as delivered and installed.
 - a. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 - b. Refer to individual Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
- F. Product Schedule or List: Prepare and submit a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
 5. Submit product schedule in the following format:
 - a. PDF electronic file.
- G. Application for Payment and Schedule of Values: Comply with requirements specified in Section 01 29 00 "Payment Procedures."
- H. Coordination Drawing Submittals: Comply with requirements specified in Section 01 31 00 "Project Management and Coordination."

- I. Subcontract List: Prepare and submit 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. Submit on the form included in Document 00 60 00 "Forms," "Subcontractors and Major Material Suppliers List."
- 1. Submit subcontract list in the following format:
 - a. PDF electronic file.
- J. Contractor's Construction Schedule: Comply with requirements specified in Section 01 32 00 "Construction Progress Documentation" for action required.
- K. Construction Photographs and Videos: Comply with requirements in Section 01 32 00 "Construction Progress Documentation."
- L. Daily Construction Reports: Comply with requirements specified in Section 01 32 00 "Construction Progress Documentation."
- M. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 01 40 00 "Quality Requirements."
- N. Certified Surveys: Comply with requirements specified in Section 01 73 00 "Execution."
- O. Closeout Submittals: Comply with requirements specified in Section 01 77 00 "Closeout Procedures."
- P. Operation and Maintenance Data: Submit written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements specified in Section 01 77 00 "Closeout Procedures." Section 01 78 23 "Operation and Maintenance Data."
- Q. Qualification Data: Submit written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- R. Welding Certificates: Prepare and submit written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
- S. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized by manufacturer for this specific Project.

- T. **Manufacturer Certificates:** Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.
- U. **Product Certificates:** Submit written statements on manufacturer's letterhead certifying that product complies with requirements.
- V. **Material Certificates:** Submit written statements on manufacturer's letterhead certifying that material complies with requirements.
- W. **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.
- X. **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.
- Y. **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:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.
- Z. **Preconstruction Test Reports:** Prepare and 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.
- AA. **Compatibility Test Reports:** Prepare and 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.
- BB. **Field Test Reports:** Prepare and submit reports, written by a qualified testing agency, on testing agency's standard form, 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.

- CC. Manufacturer's Field Reports: Prepare and submit written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
1. Name, address, and telephone number of factory-authorized service 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.
- DD. Manufacturer's Instructions: Submit written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
1. Preparation of substrates.
 2. Required substrate tolerances.
 3. Sequence of installation or erection.
 4. Required installation tolerances.
 5. Required adjustments.
 6. Recommendations for cleaning and protection.
- EE. Insurance Certificates and Bonds: Prepare and submit written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.
- FF. Material Maintenance Submittals: Comply with requirements specified in individual Sections for quantity and disposition of delivery of extra stock.
- GG. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally-signed PDF electronic file digitally 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.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect[and Construction Manager].
- B. Project Closeout and Maintenance/Material Submittals: Refer to requirements in Section 01 77 00 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, coordinated, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S [AND CONSTRUCTION MANAGER'S] ACTION

- A. General: Architect will not review submittals that have not been properly transmitted, reviewed by Contractor, or do not bear Contractor's approval stamp and will return them without action.

- B. Action Submittals: Architect will review submittal , make marks to indicate corrections or revisions required, and return it to Contractor. Architect will stamp each submittal with an action stamp as illustrated at the end of this Section, and will mark stamp appropriately to indicate action, as follows:
1. "NO EXCEPTIONS TAKEN": No further review of Submittal required.
 2. "MAKE CORRECTIONS AS NOTED. Resubmittal not required unless Contractor cannot comply with corrections noted.": Incorporate corrections in Work. If Contractor cannot comply with corrections as noted, revise to respond to exceptions and resubmit.
 3. "REVISE AS NOTED AND RESUBMIT": Revise as noted and resubmit for further review.
 4. "RESUBMIT PROPERLY Submittal not reviewed for reasons noted."
 5. "NOT REVIEWED Submittal not required by Contract Documents.": Remove from submittal log.
 6. "RECEIVED FOR CLIENT'S RECORD ONLY. Submittal not reviewed."
- C. 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.
- D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- E. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- F. Submittals not required by the Contract Documents will not be reviewed and may be discarded or returned marked "NOT REVIEWED."
- G. Substitution items received as product data, shop drawing, or sample submittals required by individual Sections will be returned to Contractor without review. Comply with requirements in Section 01 25 00 "Substitution Procedures" for submission of substitution request.
- H. Submittals will not be considered complete without the required LEED supporting documentation that is required for the submission of the Project to USGBC and LEED Criteria Worksheet.
1. Architect reserves the right to reject any submittal that is missing the required LEED-related documentation.
 2. Adjustments to the Construction Schedule will not be allowed for failure of the Contractor to submit all required LEED-related documentation as part of the first submission, or in an otherwise timely manner.
 3. Increase of the Contract Sum will not be allowed in order to meet the specified LEED-related requirements.

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Permit and IFC

**Steamboat Base Village
Redevelopment**
Steamboat Springs, Colorado

END OF SECTION 01 33 00

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. This Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting 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-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-control services required by Architect, Owner, Commissioning Authority, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Sections:
 - 1. Section 01 73 00 "Execution" for repair and restoration of construction disturbed by testing and inspecting activities.
 - 2. Divisions 02 through 49 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and ensure that proposed construction complies with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that completed construction complies with requirements. Services do not include contract enforcement activities performed by Architect.

- C. Mockups: Full-size physical assemblies that are constructed on-site, unless indicated otherwise. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
1. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
- D. 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.
- E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Source Quality-Control Testing: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).
- G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. 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, 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).
- J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five unless noted otherwise within the specifications. 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.
- K. Professional Engineer: Engineer currently licensed to practice in the State of Colorado .

1.4 CONFLICTING REQUIREMENTS

- A. Referenced Standards: If compliance with two or more standards is specified and the standards 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 a decision 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.

1.5 ACTION SUBMITTALS

- A. Shop Drawings: For integrated exterior mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.
 - 1. Indicate manufacturer and model number of individual components.
 - 2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.6 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.
- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Architect.
 - 2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Architect.
- 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. Description of test and inspection.
 3. Identification of applicable standards.
 4. Identification of test and inspection methods.
 5. Number of tests and inspections required.
 6. Time schedule or time span for tests and inspections.
 7. Entity responsible for performing tests and inspections.
 8. Requirements for obtaining samples.
 9. Unique characteristics of each quality-control service.
- F. Testing Agency and Inspection Reports: Prepare and submit certified written reports that include the following:
1. Date of issue.
 2. Project title and number.
 3. Name, address, and telephone number 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. Ambient conditions at time of sample taking and testing and inspecting.
 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.
- G. 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, and telephone number 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.
- H. 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, and telephone number 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.
- I. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.7 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice 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 full-time 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. .
- 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.
 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 the 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.

1.8 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Fabricator Qualifications: A firm experienced and expert in producing products similar to those indicated for this Project and with a three-year record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. 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.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a three-year record of successful in-service performance.
- E. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a five-year record of successful in-service performance.
- F. 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.
- G. Professional Engineer Qualifications: A professional engineer 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 products that are similar to those indicated for this Project in material, design, and extent.

- H. Specialists: Certain sections of the Specifications 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. Requirement for specialists shall not supersede building codes and similar regulations governing the Work, nor interfere with local trade-union jurisdictional settlements and similar conventions.
- I. Testing Agency Qualifications: An NRTL, an NVLAP-accredited, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented by ASTM E 329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities..
1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- 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 and assemblies 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. Fabricate and install test assemblies and mockups using installers who will perform the same tasks for 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 specified in individual Sections, to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.

2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 5. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 7. Demolish and remove mockups when directed, unless otherwise indicated.
- L. Integrated Exterior Mockups: Construct integrated exterior mockup according to approved Shop Drawings and with location 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.
1. Engineering for mockup structural support and foundation is by Contractor.

1.9 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 the types of testing and inspecting they are engaged to perform.
 2. Payment for these services will be made from testing and inspecting 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 required to verify that the Work complies with requirements, whether specified or not..
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. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

- a. Contractor shall not employ the 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 inspecting 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 inspecting 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.
 7. Provide quality assurance and control services required due to changes in the Work proposed by or made by the Contractor.
 8. Provide quality control services for Work done contrary to the Contract Documents, without prior notice, when so specified, or without proper supervision.
 9. Overtime expenses and schedule delays accruing as a result of executing quality control services shall be the Contractor's responsibility and shall not be charged to the Owner.
- C. **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."
- D. **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.
- E. **Retesting/Reinspecting:** Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that revised or replaced Work that failed to comply with requirements established by the Contract Documents. Architect retains the right to require the use of a different testing agency for retesting and reinspecting.
- F. **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 location 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 requirements of the Contract Documents or approve or accept any portion of the Work.
 6. Do not perform any duties of Contractor.
 7. Attend Project progress meetings as requested by Architect.
- G. Associated Services: Cooperate with agencies 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 inspecting. Assist agency in obtaining samples.
 4. Facilities for storage and field-curing of test samples.
 5. Delivery of samples to testing agencies or arranging for pick-up of test samples after normal business hours.
 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 inspecting 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 inspecting.
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 schedule concurrently with Contractor's Construction Schedule as specified in Section 01 32 00 "Construction Progress Documentation."
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.

1.10 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified testing agency special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:

- B. Special Tests and Inspections: Conducted by a qualified testing agency special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections, as listed in the drawings, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews 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.
 7. .

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

A.

3.2 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, Commissioning Authority's,reference during normal working hours.

3.3 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, 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 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," "approved," "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": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "As Required": As required by regulatory bodies, by referenced standards, by existing conditions, by generally accepted construction practice or by the Contract Documents. In the event of ambiguity or conflicts, the most stringent requirements shall apply.
- J. "By Others" refers to work that is not a part of the Contract.

- K. "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.
- L. "NIC": "Not in Contract" means the work or the item indicated is not a part of the Contract and will be provided by the Owner.
- M. "Day": Unless stated otherwise, "day" means a calendar day.

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, except comply with standards having different revision dates as referenced in the codes as indicated on Drawings.
- C. Copies of Standards: Each entity engaged in construction on Project must 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 and make them available on request.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 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 the following administrative and procedural requirements: selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Sections:
 - 1. Section 01 25 00 "Substitution Procedures" for requests for substitutions.
 - 2. Section 01 42 00 "References" for applicable industry standards for products specified.
 - 3. Section 01 77 00 "Closeout Procedures" for submitting warranties for contract closeout.
 - 4. Divisions 03 through 49 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.3 DEFINITIONS

- A. Products: Items purchased 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, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, 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: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.
- C. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
- D. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

1.4 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify 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 one week 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 Approval: 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, product selected shall be 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.

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.
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 ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
 5. Store products to allow for inspection and measurement of quantity or counting of units.
 6. Store materials in a manner that will not endanger Project structure.
 7. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 9. Protect stored products from damage and liquids from freezing.
 10. 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. Submit a draft for approval before final execution.
1. **Manufacturer's Standard Form:** Modified to include Project-specific information and properly executed.

2. Specified Form: Forms are included with the Specifications. Prepare a written document using appropriate form properly executed.
 3. Refer to Divisions 03 through 49 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements Section 01 77 00 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

- A. Components, materials, or parts required to be supplied in quantity within a Section shall be of the same manufacture, shall be interchangeable, and shall be the same with regard to function, texture, pattern, and color.
- B. Except for building equipment in service areas, no manufacturers' labels or name plates shall be visible on any component, unless required by local authorities having jurisdiction.

2.2 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that 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: Unless custom products or nonstandard options are specified, provide products of both quality and type that have been used successfully in similar situations on equal quality projects.
 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Architect will make selection.
 5. Where products are accompanied by the term "match sample," sample to be matched is Architect's.
 6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
- B. Product Selection Procedures: Procedures for product selection include the following:
 1. 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.

2. **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.
3. **Products:**
 - a. **Restricted List:** 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] [will not] be considered[unless otherwise indicated].
 - b. **Nonrestricted List:** Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.
4. **Manufacturers:**
 - a. **Restricted List:** 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.
 - b. **Nonrestricted List:** Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
5. **Basis-of-Design Products:** Where Specification paragraphs or subparagraphs titled "Basis-of-Design Product[s]" are included and also introduce or refer to a list of manufacturers' names, provide either the specified 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 provisions in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
6. **Visual Matching Specification:** Where Specifications require matching an established Sample, provide a product (and manufacturer) that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches satisfactorily.
 - a. If no product available within specified category matches satisfactorily and complies with other specified requirements, comply with requirements in Section 01 25 00 "Substitution Procedures" for proposal of product.
7. **Visual Selection Specification:**

- a. Standard Range: Where Specifications include the phrase "as selected by Architect from manufacturer's standard range" or similar phrase, Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that does not include premium items.
 - b. Full Range: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.
8. Allowances: Refer to individual Specification Sections and "Allowance" provisions in Division 01 for allowances that control product selection and for procedures required for processing such selections.

2.3 COMPARABLE PRODUCTS

- A. Conditions for Consideration: 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 the proposed product does not require extensive revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.

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. This Section includes general 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 Sections include the following:
 - 1. Section 01 31 00 "Project Management and Coordination" for procedures for coordinating field engineering with other construction activities.
 - 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, and final cleaning.
 - 4. Section 02 41 19 "Selective Demolition" for demolition and removal of selected portions of the building.

1.3 DEFINITIONS

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

1.4 QUALITY ASSURANCE

- A. 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.
 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.
 - h. .
 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.

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 requirements in Section 01 81 13 "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 utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
 1. Before construction, verify the location and points of connection of utility services.
- B. 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 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; and underground electrical services.
 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- C. 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.

- D. 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.
- E. 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 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 interpretation to Architect according to Section 01 26 13 "Request for Interpretation."

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 [and Construction Manager] promptly.
- B. General: Engage a land surveyor professional engineer to lay out the Work using accepted surveying practices.
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 - 2. Establish limits on use of Project site.

3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 4. Inform installers of lines and levels to which they must comply.
 5. Check the location, level and plumb, of every major element as the Work progresses.
 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and 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 [and Construction Manager].

3.4 FIELD ENGINEERING

- A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect . Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect [and Construction Manager] before proceeding.
 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- B. Benchmarks: Establish and maintain a minimum of [two] <Insert number> 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.

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. Where indicated to remain exposed, arrange overhead systems in an orderly manner.
 - 4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches 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: Do not use tools or equipment that produces harmful 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 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. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.
- K. Protect adjacent property and adjoining work, including sealant bond surfaces, from spillage or blow-over of coatings, paints, sprayed fire-resistive material, and other spray-applied products. Cover adjoining and nearby surfaces, including live plants and grass, if there is possibility of spray-applied products being deposited on surfaces.

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 14 00 "Work Restrictions."
- 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 minimize 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. Avoid cutting steel reinforcement.
 - a. Locate steel reinforcement using Ground Penetrating Radar or Ferroskan prior to cutting or drilling reinforced concrete and masonry. If existing steel reinforcement is in proposed cut or hole location, contact Architect before proceeding with the Work.
 4. Excavating and Backfilling: Comply with requirements in applicable Division 31 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. Ceramic Tile: Provide ceramic tile and grout to match existing. Remove and replace tile damaged as a result of Work of this Contract. Comply with TCNA's "Handbook for Ceramic Tile Installation" for installation method to match existing. Lay tile in grid pattern to match existing. Make joints between existing and new tile same width so patches are not apparent in finished work.
 6. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. 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 materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F.
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 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:** Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. **Waste Disposal:** Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted. Comply with 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 assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

- A. **Start equipment and operating components** to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. **Adjust operating components** for proper operation without binding. Adjust equipment for proper operation.
- C. **Test each piece of equipment** to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. **Manufacturer's Field Service:** If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Section 01 40 00 "Quality Requirements."

3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. 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 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 02 41 16 "Structure Demolition" for disposition of waste resulting from demolition of buildings, structures, and site improvements.
 - 2. Section 02 41 19 "Selective Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements, and for disposition of hazardous waste.
 - 3. Section 04 20 00 "Unit Masonry" for disposal requirements for masonry waste.

1.2 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- 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.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of 50 percent by weight of total non-hazardous 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) Plastic pails.

1.4 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 10 days of date established for commencement of the Work.

1.5 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 points of waste.
 3. Total quantity of waste in tons.
 4. Quantity of waste salvaged, both estimated and actual in tons.
 5. Quantity of waste recycled, both estimated and actual in tons.
 6. Total quantity of waste recovered (salvaged plus recycled) in tons.
 7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- C. 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. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. 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 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.

1.7 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to ASTM E 1609 and 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 site-clearing and 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.
 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Reclamation Programs: Research and prepare a plan to work with manufacturers who have programs to receive used materials. Known reclamation programs are available from, but not limited to, the following manufacturers:
 - 1. Carpet:
 - a. Reentry Program by Interface.
 - b. Antron, In vista.
 - c. CON-tinuum by Constantine & Covanta.
 - d. Local carpet and carpet cushion reclamation centers may be found on <http://www.carpetrecovery.org/>.
 - 2. Ceiling Panels: Armstrong World Industries, Inc.
 - 3. Resilient Flooring: ReUse Program by Tarkett.

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 - 1. Comply with operation, termination, and removal requirements in Section 01 50 00 "Temporary Facilities and Controls."
- B. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
 - 2. Comply with Section 01 50 00 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

- A. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
- B. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
- C. Plumbing Fixtures: Separate by type and size.
- D. Lighting Fixtures: Separate lamps by type and protect from breakage.
- E. 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 Contractor.
- 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.

3.4 RECYCLING DEMOLITION WASTE

- A. Asphalt Paving: Grind asphalt to maximum 4-inch size.
- B. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
 - 1. Pulverize masonry to maximum 1-1/2-inch 4-inch size.
- C. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- D. 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.
- E. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.
- F. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
- G. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.
- H. 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.
- I. 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.
- J. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
- K. Conduit: Reduce conduit to straight lengths and store by type and size.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, 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. Burning: Do not burn waste materials.

C. Disposal: Remove waste materials from Owner's property and legally dispose of them.

3.7 ATTACHMENTS

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-7 for construction waste
- F. Form CWM-8 for demolition waste.

END OF SECTION 01 74 19

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout.

1.2 ACTION SUBMITTALS

- A. Contractor's List of Incomplete Items (Punch List): Initial submittal at Substantial Completion.
- B. Certified List of Incomplete Items: Final submittal at Final Completion.

1.3 CLOSEOUT SUBMITTALS

- A. Certificate of Insurance: For continuing coverage.
- B. Project Record Documents:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record product data.
 - 4. Miscellaneous record submittals.
- C. Operation and maintenance manual(s).
- D. Warranties.

1.4 MAINTENANCE MATERIAL SUBMITTALS

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

1.5 SUBSTANTIAL COMPLETION PROCEDURES

- A. Submittals Prior to Substantial Completion: Complete the following a minimum of 5 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Prepare and submit a list of incomplete items (punch list), indicating the value of items on the list, and reasons why the Work is not complete.
 2. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, final certifications, and similar documents.
 3. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 4. Prepare and submit Project Record Documents, operation and maintenance manuals, and similar final record information.
 5. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner. Label with manufacturer's name and model number where applicable.
 - 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 Owner's signature for receipt of submittals.
 6. Submit test/adjust/balance records.
- B. Procedures Prior to Substantial Completion: Complete the following 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 01 79 00 "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.

- C. Inspection: Submit a written request for inspection for 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. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for Final Completion.

1.6 FINAL COMPLETION PROCEDURES

- A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
1. Submit a final Application for Payment.
 2. Submit copy of Contractor's original Substantial Completion inspection list with Architect's annotations of items to be completed or corrected (punch list), endorsed and dated by Architect. Copy shall be certified by Contractor and state that each item has been completed or otherwise resolved for acceptance.
- B. Inspection: Submit a written request for final inspection for acceptance a minimum of 5 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. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.7 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Preparation: 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, 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.
- B. Submit list of incomplete items in MS Excel electronic file. Architect will return annotated electronic file.

1.8 PROJECT RECORD DOCUMENTS

- A. General: Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.
- B. Record Drawings: Maintain and submit one set of blue- or black-line white prints of Contract Drawings and Shop Drawings.
- 1. 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 prepare the marked-up record prints.
 - a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later, and the locations of those items that need to be located for servicing.
 - b. Accurately record information in a readily understandable drawing technique.
 - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 - d. Mark record prints completely and accurately.
 - e. Mark important additional information that was either shown schematically or omitted from original Drawings.
 - f. Note Change Order numbers, alternate numbers, and similar identification where applicable.
- C. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Clearly mark copy 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. Note related Change Orders, Record Drawings, and Product Data, where applicable.

- D. Record Product Data: Submit one copy of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.
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 Drawings, where applicable.
- E. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections such as tests and inspections, and inspections by authorities having jurisdiction. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1.9 OPERATION AND MAINTENANCE MANUALS

- A. Assemble a complete set of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:
1. Operation Data:
 - a. Emergency instructions and procedures.
 - b. System, subsystem, and equipment descriptions, including operating standards.
 - c. Operating procedures, including startup, shutdown, seasonal, and weekend operations.
 - d. Description of controls and sequence of operations.
 - e. Piping diagrams.
 - f. Noise and vibration adjustments.
 - g. Effective energy utilization.
 2. Maintenance Data:
 - a. Manufacturer's information, including list of spare parts.
 - b. Name, address, and telephone number of Installer or supplier.
 - c. Maintenance procedures.
 - d. Maintenance and service schedules for preventive and routine maintenance.
 - e. Maintenance record forms.
 - f. Sources of spare parts and maintenance materials.
 - g. Copies of maintenance service agreements.
 - h. Copies of warranties and bonds.
 - i. Cleaning.
 - j. Control sequence.

- k. Fuels, lubricants, tool, and other related items.
 - l. Identification systems.
- B. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL," Project name, and subject matter of contents.

1.10 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, 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.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

PART 3 - EXECUTION

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 and Commissioning Authority 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.
- C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect and Commissioning Authority 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 and Commissioning Authority will return copy with comments.
1. Correct or revise each manual to comply with Architect's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's and Commissioning Authority's comments and prior to commencing demonstration and training.
- E. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary, to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 1. Title page.
 2. Table of contents.
 3. Manual contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of 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 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.

1.8 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.

1.9 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.

1.10 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 copies of record Drawings as follows:
 - a. Final Submittal:
 - 1) Submit record digital data files and three set(s) of record digital data file plots.
 - 2) Plot each drawing file, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.
- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

1.4 RECORD DRAWINGS

- A. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
 1. Format: Annotated PDF electronic file with comment function enabled.
 2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 3. Refer instances of uncertainty to Architect through Construction Manager 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. 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 paper copy.

1.6 RECORD PRODUCT DATA

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 - 3. Note related Change Orders, record Specifications, and record Drawings where applicable.
- C. Format: Submit record Product Data as annotated PDF electronic file.
 - 1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

1.7 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals as PDF electronic file.
 - 1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

1.8 MAINTENANCE OF RECORD DOCUMENTS

- A. Maintenance of Record Documents: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 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.

1.4 CLOSEOUT SUBMITTALS

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

- d. Name of Construction Manager.
 - e. Name of Contractor.
 - f. 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. 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 has 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. 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 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 a demonstration performance-based test.
- F. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 79 00

SECTION 01 81 13.14 - SUSTAINABLE DESIGN REQUIREMENTS - LEED v4 BD+C

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 prerequisites and credits needed for Project to obtain "LEED Version 4 for Building Design and Construction" (LEED v4 BD+C) Certified certification based on USGBC's LEED v4 BD+C.
 - 1. Specific requirements for LEED are also included in other Sections.
 - 2. Some 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.
 - 3. 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 Version 4 for Building Design and Construction."
 - 1. Definitions that are a part of "LEED Version 4 for Building Design and Construction" (LEED v4 BD+C) 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. 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 100 miles 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 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. "Preconsumer" 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 or Virtually. Review LEED requirements and action plans for meeting requirements.

1.5 ADMINISTRATIVE REQUIREMENTS

- A.
- B. Submit documentation to USGBC and respond to questions and requests from USGBC regarding 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. Environmental Product Declarations complying with LEED requirements.
2. Documentation for products that comply with LEED requirements for multi-attribute optimization.
3. Sustainability reports for products that comply with LEED requirements for raw material and source extraction reporting.
4. Documentation for products that comply with LEED requirements for leadership extraction practices. Include the following:
 - a. Product data and certification letter from product manufacturers, indicating participation in an extended producer responsibility program and statement of costs.
 - b. Product data and certification for bio-based materials, indicating that they comply with requirements. Include statement of costs.
 - c. Product data and chain-of-custody certificates for products containing certified wood. Include statement of costs.
 - d. Receipts for salvaged and refurbished materials used for Project, indicating sources and costs.
 - e. Product data and certification letter from product manufacturers, indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement of costs.
 - f. Documentation for regional materials, indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material and costs of regional materials.
5. Material ingredient reports for products that comply with LEED requirements for material ingredient reporting.
6. Documentation for products that comply with LEED requirements for material ingredient optimization.
7. Documentation for products that comply with LEED requirements for product manufacturer supply chain optimization.
 - a. Include documentation for regional materials, indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material and costs of regional materials.
8. Documentation complying with Section 01 74 19 "Construction Waste Management and Disposal."

9. Product data for adhesives and sealants used inside the weatherproofing system, indicating VOC content and laboratory test reports showing compliance with requirements for low-emitting materials.
10. Product data for paints and coatings used inside the weatherproofing system, indicating VOC content and laboratory test reports showing compliance with requirements for low-emitting materials.
11. Laboratory test reports for flooring, indicating compliance with requirements for low-emitting materials.
12. Laboratory test reports for products containing composite wood or agrifiber products or wood glues, indicating compliance with requirements for low-emitting materials.
13. Laboratory test reports for ceilings, walls, and thermal insulation, indicating compliance with requirements for low-emitting materials.
14. Construction Indoor-Air-Quality (IAQ) Management:
 - a. Construction IAQ management plan.
 - b. Product data for temporary filtration media.
 - c. Product data for filtration media used during occupancy.

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.
- C. Sustainable Design Action Plans: Provide preliminary submittals within 14 days of date established for commencement of the Work, indicating how the following requirements will be met:
 1. List of proposed products with Environmental Product Declarations.
 2. List of proposed products complying with requirements for multi-attribute optimization.
 3. List of proposed products complying with requirements for raw material and source extraction reporting.
 4. List of proposed products complying with requirements for leadership extraction practices.
 5. List of proposed products complying with requirements for material ingredient reporting.
 6. List of proposed products complying with requirements for material ingredient optimization.

7. List of proposed products complying with requirements for product manufacturer supply chain optimization.
 8. Waste management plan complying with Section 01 74 19 "Construction Waste Management and Disposal."
 9. 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 Construction Coordinator: Engage an experienced LEED-accredited professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator and indoor air quality coordinator.
1. LEED Coordinator shall keep the logs and manifests for all LEED "Construction" submissions.
 2. LEED Coordinator shall compile and review all documentation required to support the achievement of all credits identified as "Construction" credits.
 3. LEED Coordinator shall be responsible for the quality of all LEED-related construction methods procedures, and materials.
 4. LEED Coordinator shall be responsible for the preparation of all "Construction" related documentation.
 5. LEED Coordinator shall be responsible for the upload and form completion of all "Construction" related documentation.
- B. LEED Project Team Administrator will process uploaded and completed forms to LEED Online and submit all required LEED documentation to USGBC.
- C. LEED Project Team Administrator will review all LEED "Construction" credit forms and documentation for completeness, but not for compliance with the credit requirements.
- D. Architect's Consultants and Contractor are expected to be the primary party responsible for documenting the credits to which they are assigned.
- E. LEED Project Team Administrator will coordinate the "Design" and "Construction" Preliminary and Final submittals to USGBC LEED Online.

PART 2 - PRODUCTS

2.1 MATERIALS

- 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.
- B. At least 20 different products from at least five different manufacturers shall have Environmental Product Declarations that comply with LEED requirements. Industry-wide (generic) Environmental Product Declarations shall be valued as one-half of a product.
- C. At least 50 percent, by cost, of the permanently installed products for the Project shall comply with LEED requirements for multi-attribute optimization.
- D. At least 20 different products from at least five different manufacturers shall have publicly released reports that comply with LEED requirements for raw material source and extraction reporting. Self-declared reports by manufacturers shall be valued as one-half of a product.
- E. At least 20 different products from at least five different manufacturers shall comply with LEED requirements for material ingredient reporting.
- F. At least 25 percent, by cost, of the permanently installed products for the Project shall comply with LEED requirements for material ingredient optimization.
- G. At least 25 percent, by cost, of the permanently installed products for the Project shall comply with LEED requirements for product manufacturer supply chain optimization.
- H. Not less than 25 percent of building materials, by cost, shall comply with LEED requirements for leadership extraction practices.
 - 1. Structure and enclosure materials shall not be more than 30 percent, by cost, of the materials used to comply with this requirement.
- I. Extended Producer Responsibility Program: Not less than 25% percent of building materials, by cost, shall be manufactured by a participant in an extended producer responsibility program.
- J. Recycled Content: Building materials shall have recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content for Project constitutes a minimum of 25% percent of cost of materials used for Project.

- K. 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.
 - 1. Do not include furniture, plumbing, mechanical and electrical components, and specialty items, such as elevators and equipment, in the calculation.
- L. Certified Wood: 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.

2.2 LOW-EMITTING MATERIALS

- A. Paints and Coatings: 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: 50 g/L.
 - 2. Nonflat Paints and Coatings: 50 g/L.
 - 3. Dry-Fog Coatings: 150 g/L.
 - 4. Primers, Sealers, and Undercoaters: 100 g/L.
 - 5. Rust-Preventive Coatings: 100 g/L.
 - 6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
 - 7. Pretreatment Wash Primers: 420 g/L.
 - 8. Clear Wood Finishes, Varnishes: 275 g/L.
 - 9. Clear Wood Finishes, Lacquers: 275 g/L.
 - 10. Floor Coatings: 50 g/L.
 - 11. Shellacs, Clear: 730 g/L.
 - 12. Shellacs, Pigmented: 550 g/L.
 - 13. Stains: 100 g/L.
- B. Paints and Coatings: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the 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. Adhesives and Sealants: 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 (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 Primer for Plastic: 550 g/L.
27. Sheet-Applied Rubber Lining Adhesives: 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 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.

- D. Adhesives and Sealants: For field applications that are inside the weatherproofing system, 90 percent of adhesives and sealants shall comply with the 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."

- E. Flooring: Flooring shall comply with the 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."
- F. Composite Wood: Composite wood, agrifiber products, and adhesives shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
- G. Ceilings, Walls, and Thermal Insulation: Ceilings, walls, and thermal insulation shall comply with the 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."

PART 3 - EXECUTION

3.1 NONSMOKING BUILDING

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

3.2 CONSTRUCTION WASTE MANAGEMENT

- A. Comply with Section 01 74 19 "Construction Waste Management and Disposal."

3.3 CONSTRUCTION IAQ MANAGEMENT

- A. 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 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.
- B. The EPA standard referenced in first subparagraph below is available from Department of Commerce, National Technical Information Service.

END OF SECTION 01 81 13.14

5/17/2021

This corresponds to:

Certified

(A) Architect (Gensler)	(GC) General Contractor
(LD) LEED Consultant	(CX) Commissioning Agent
(C) Client	(LC) Lighting Consultant
(MEP) MEP Engineer	(TC) Technology Consultant
(LA) Landscape Architect	(FP) Furniture Provider
(CV) Civil Engineer	

SECTION 01 81 19 - INDOOR AIR QUALITY (IAQ) MANAGEMENT

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. Special requirements for Indoor Air Quality (IAQ) management during construction operations.
 - a. Control of emissions during construction.
 - b. Moisture control during construction.
 - 2. Procedures for testing baseline IAQ. Baseline IAQ requirements specify maximum indoor pollutant concentrations for acceptance of the facility.
- B. Related Sections:
 - 1. Section 01 91 13 "General Commissioning" for coordination with commissioning activities.
 - 2. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for cleaning of HVAC system including ductwork, air intakes and returns, and changing of filters.

1.3 REFERENCES

- A. Definitions: Definitions pertaining to sustainable development: As defined in ASTM E 2114.
 - 1. Adequate Ventilation: Ventilation, including air circulation and air changes, required to cure materials, dissipate humidity, and prevent accumulation of particulates, dust, fumes, vapors, or gases.
 - 2. Hazardous Materials: Any material that is regulated as a hazardous material in accordance with 49 CFR 173, requires a Material Safety Data Sheet (MSDS) in accordance with 29 CFR 1910.1200, or which during end use, treatment, handling, storage, transportation or disposal meets or has components which meet or have the potential to meet the definition of a Hazardous Waste in accordance with 40 CFR 261.

- a. Hazardous materials include pesticides, biocides, and carcinogens as listed by recognized authorities, such as the Environmental Protection Agency (EPA) and the International Agency for Research on Cancer (IARC).
3. Indoor Air Quality (IAQ): The composition and characteristics of the air in an enclosed space that affect the occupants of that space. The indoor air quality of a space refers to the relative quality of air in a building with respect to contaminants and hazards and is determined by the level of indoor air pollution and other characteristics of the air, including those that impact thermal comfort such as air temperature, relative humidity and air speed.
4. Interior Final Finishes: Materials and products that will be exposed at interior, occupied spaces; including flooring, wallcovering, finish carpentry, ceilings, and sealants.
5. Packaged Dry Products: Materials and products that are installed in dry form and are delivered to the site in manufacturer's packaging; including carpets, resilient flooring, ceiling tiles, and insulation.
6. Wet Products: Materials and products installed in wet form, including paints, sealants, adhesives, special coatings, and other materials which require curing.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Preconstruction Conference: After award of Contract and prior to the commencement of the Work, schedule and conduct meeting with Owner and Architect to discuss the proposed IAQ Management Plan and to develop mutual understanding relative to details of environmental protection.

1.5 SUBMITTALS

- A. Indoor Air Quality (IAQ) Management Plan: Not less than 10 days before the preconstruction conference, prepare and submit an IAQ Management Plan including, but not limited to, the following:
 1. Procedures for control of emissions during construction.
 - a. Identify schedule for application of interior finishes.
 2. Procedures for moisture control during construction.
 - a. Identify porous materials and absorptive materials.
 - b. Identify schedule for inspection of stored and installed absorptive materials.
 3. Revise and resubmit Plan as required by Architect.
 - a. Approval of Contractor's Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations.

B. Product Data:

1. Submit product data for filtration media used during construction and during operation. Include Minimum Efficiency Reporting Value (MERV).
2. Submit air pressure difference maps for each mode of operation of HVAC.
3. Material Safety Data Sheets: Submit MSDSs for inclusion in Operation and Maintenance Manual for the following products.
 - a. Adhesives.
 - b. Floor and wall patching/leveling materials.
 - c. Caulking and sealants.
 - d. Insulating materials.
 - e. Fireproofing and firestopping.
 - f. Carpet.
 - g. Paint.
 - h. Clear finish for wood surfaces.
 - i. Lubricants.
 - j. Cleaning products.

C. Inspection and Test Reports:

1. Moisture control inspections.
2. Moisture content testing.
3. Moisture penetration testing.
4. Microbial growth testing.
5. Baseline Indoor Air Quality test report.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Minimum of 5 years experience in performing the types of testing specified herein.

PART 2 - PRODUCTS

2.1 GENERAL ENVIRONMENTAL ISSUES

- A. Mold and Mildew: Materials that have evidence of growth of molds or mildew are not acceptable, including both stored and installed materials. Immediately remove from site and dispose of properly.

- B. Moisture Stains: Materials that have evidence of moisture damage, including stains, are not acceptable, including both stored and installed materials. Immediately remove from site and dispose of properly.

2.2 AIR FILTRATION MEDIA

- A. Minimum Efficiency Reporting Value (MERV) as determined by ASHRAE 52.2:
 - 1. MERV-8 for filtration media used at each return air grill, if used during construction.
 - 2. MERV-13, for filtration media installed at the end of construction and prior to occupancy.

2.3 CLEANING PRODUCTS

- A. Use low-toxic and lowest-emitting spot removers and cleaning agents for surfaces, equipment, and workers' personal use.
- B. Use HEPA-filter equipped vacuum cleaners for the final cleaning.

PART 3 - EXECUTION

3.1 IAQ MANAGEMENT - EMISSIONS CONTROL

- A. Seal return registers during construction operations.
- B. Provide temporary exhaust during construction operations
- C. To the greatest extent possible, isolate and/or shut down the return side of the HVAC system during construction. When ventilation system must be operational during construction activities, provide temporary filters.
- D. Source Control:
 - 1. Provide low and zero VOC materials as specified.
 - 2. Do not use products in combination with or in contact with other products that can be identified as combining to form toxic fumes or sustained odors.
- E. Pathway Interruption: Isolate areas of work as necessary to prevent contamination of clean or occupied spaces. Provide pressure differentials and/or physical barriers to protect clean or occupied spaces.
- F. Housekeeping: During construction, maintain project and building products and systems to prevent contamination of building spaces.

- G. Do not permit use of tobacco products inside the building, and within 25 feet of building entrance during construction.
- H. Temporary Ventilation: Provide an ACH (air changes per hour) of 1.5 or more and as follows:
 - 1. Provide minimum 48-hour pre-ventilation of packaged dry products prior to installation. Remove from packaging and ventilate in a secure, dry, well-ventilated space free from strong contaminant sources and residues. Provide a temperature range of 60 deg F minimum to 90 deg F maximum continuously during the ventilation period. Do not ventilate within limits of Work unless otherwise approved by Architect.
 - 2. Provide adequate ventilation during and after installation of interior wet products and interior final finishes.
 - 3. Provide filtration media with a Minimum Efficiency Reporting Value (MERV) of 8 as determined by ASHRAE 52.2 during construction and during Owner occupancy. Coordinate with Work of Division 23, Heating, Ventilating, and Air Conditioning (HVAC).
 - a. Replace filters during construction as necessary to protect equipment and indoor air quality.
- I. Scheduling: Schedule construction operations involving wet products prior to packaged dry products to the greatest extent possible.
 - 1. Do not use solvents within interior areas that may penetrate and be retained in absorptive materials such as concrete, gypsum board, wood, cellulose products, fibrous material, and textiles.
- J. Inspect ductwork for refuse, contaminants, moisture, and other foreign contamination prior to commissioning by Owner. Notify Owner of satisfactory inspection prior to beginning of commissioning.

3.2 IAQ MANAGEMENT - MOISTURE CONTROL

- A. Housekeeping:
 - 1. Keep materials dry. Protect stored on-site and installed absorptive materials from moisture damage.
 - 2. Verify that installed materials and products are dry prior to sealing and weatherproofing the building envelope.
 - 3. Install interior absorptive materials only after building envelope is sealed and weatherproofed.
- B. Inspections: Document and report results of inspections; state whether or not inspections indicate satisfactory conditions.

1. Examine materials for dampness as they arrive. If acceptable to Architect, dry damp materials completely prior to installation; otherwise, reject materials that arrive damp.
2. Examine materials for mold as they arrive and reject materials that arrive contaminated with mold.
3. Inspect stored and installed absorptive materials regularly for dampness and mold growth. Inspect weekly, after each rain event,
 - a. Where stored on-site or installed absorptive materials become wet, notify Architect. Inspect for damage. If acceptable to Architect, dry completely prior to closing in assemblies; otherwise, remove and replace with new materials.
4. Site Drainage: Verify that final grades of site work and landscaping drain surface water and ground water away from the building.
5. Weatherproofing: Inspect moisture control materials as they are being installed. Include the following:
 - a. Air Barrier: Verify air barrier is installed without punctures and/or other damage. Verify air barrier is sealed completely.
 - b. Flashing: Verify correct shingling of the flashing for roof, walls, windows, doors, and other penetrations.
 - c. Insulation Layer: Verify insulation is installed without voids.
 - d. Roofing: In accordance with ASTM D 7186.
6. Plumbing: Verify satisfactory pressure test of pipes and drains is performed before closing in and insulating lines.
7. HVAC: Inspect HVAC system as specified in Section 01 91 13 "General Commissioning." And, inspect HVAC to verify the following:
 - a. Condensate pans are sloped and plumbed correctly.
 - b. Access panels are installed to allow for inspection and cleaning of coils and ductwork downstream of coils.
 - c. Ductwork and return plenums are air sealed.
 - d. Duct insulation is installed and sealed.
 - e. Chilled water line and refrigerant line insulation are installed and sealed.

C. Schedule:

1. Schedule work such that absorptive materials, including but not limited to porous insulations, paper-faced gypsum board, ceiling tile, and finish flooring, are not installed until they can be protected from rain and construction-related water.
2. Weatherproof as quickly as possible. Schedule installation of moisture-control materials, including but not limited to air barriers, flashing, exterior sealants and roofing, at the earliest possible time.

- D. Testing for Moisture Content: Test moisture content of porous materials and absorptive materials to ensure that they are dry before sealing them into an assembly. Document and report result of testing. Where tests are not satisfactory, dry materials and retest. If satisfactory results cannot be obtained with retest, remove and replace with new materials.
1. Concrete: Moisture test prior to finish flooring application as specified in Division 09. and as specified herein Moisture test as per one or more of the following; unless otherwise indicated, acceptable upper limits for concrete are less than 4 percent top inch; less than 85 percent headspace RH; less than 3 lbs./1000 sq. ft./day:
 - a. ASTM F 1869 - Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
 - b. ASTM F 2170 - Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In Situ Probes.
 2. Wood: Moisture test as per ASTM D 4444 - Standard Test Methods for Use and Calibration of Hand-Held Moisture Meters; unless otherwise indicated, acceptable upper limits for wood products are less than 20 percent at center of piece; less than 15 percent at surface.
 3. Gypsum Board, Gypsum Plaster, Insulation, and Other Absorptive Materials: Moisture test with a Pinless Moisture Meter to assess patterns of moisture, if any.
- E. Testing for Moisture Penetration:
1. Reference specification sections within the Project Manual for specific Moisture Penetration tests and requirements.

3.3 BASELINE INDOOR AIR QUALITY TESTING

- A. After construction ends and prior to occupancy, conduct a baseline indoor air quality testing procedure that randomly selects sampling points for every 25,000 sq. ft., or for each contiguous floor area, whichever is larger, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air,".
- B. Demonstrate that the chemical contaminant maximum concentrations listed below are not exceeded:
1. Carbon Dioxide (CO₂): Maximum concentration of 530 parts per million per ASHRAE 62.

- a. This measurement is required only if the building is regularly occupied during the testing. Measured differential between indoor and outdoor conditions is based on occupancy type as defined by ASHRAE 62. Maximum concentration differential in parts per million = $10,300 / \text{ventilation rate per occupant, in cubic feet per minute, assuming an occupancy of 7 persons per 1000 sq. ft. of floor space.}$
 2. Formaldehyde: 27 parts per billion.
 3. Particulates (PM10): 50 micrograms per cubic meter per EPA National Ambient Air Quality Standard.
 4. Ozone: 0.075 ppm, according to ASTM D 5149.
 5. Total Volatile Organic Compounds: 500 micrograms per cubic meter per State of Washington IAQ Standard.
 6. 4-Phenylcyclohexene (4-PH): 6.5 micrograms per cubic meter per State of Washington IAQ Standard.
- C. For each building area where the maximum concentration limits are exceeded, conduct a partial building flushout, for a maximum of two weeks, then retest the indoor air quality levels to indicate the requirements are achieved.

END OF SECTION 01 81 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 cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Footings.
 - 2. Foundation walls.
 - 3. Slabs-on-grade.
 - 4. Concrete toppings.
- B. Related Sections:
 - 1. Section 07 18 00 "Traffic Coatings, for traffic coating on concrete roof.
 - 2. Section 07 26 16 "Under Slab-On Grade Vapor Retarder" for vapor retarder to be placed under new concrete.

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.

2. Submit substantiating data for each concrete mix design contemplated for use to the Architect no less than four weeks prior to first concrete placement. Data for each mix shall include the following:
 - a. Mix identification number (unique for each mix submitted).
 - b. Statement of intended mix use.
 - c. Mixture proportions.
 - d. Water/cementitious materials ratio.
 - e. Wet and dry unit weight.
 - f. Total air content.
 - g. Design slump and allowable range after additions of all admixtures.
 - h. Compressive strength tests.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
 1. Show all reinforcing, top and bottom profile of concrete element, supports below, including beams, pilasters, columns and walls, concrete walls, joists, etc. framing into element.
 2. Provide one continuous elevation at 1/4" (1:48) scale for all walls in a continuous line. Show pockets and openings in shear walls, structural slabs, beams, elevations of top of beams, walls, columns, sections through beams, pilasters, columns, and placing sequence of reinforcing for items with more than one reinforcing layer.
 3. Show locations of approved construction joints, locations of pour strips, splices of reinforcing, type of splice used and splice location. Identify all ASTM A706 and epoxy coated reinforcing locations.
- D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 1. Location of construction joints is subject to approval of Architect.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each of the following, signed by manufacturers:
 1. Cementitious materials.
 2. Admixtures.
 3. Form materials and form-release agents.
 4. Steel reinforcement and accessories.
 5. Fiber reinforcement.
 6. Curing compounds.
 7. Bonding agents.

8. Vapor retarders.
 9. Repair materials.
- B. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
1. Aggregates: Submit test reports indicating that aggregates are not potentially reactive based on the ASTM C295 or ASTM 1260 testing limits set forth in section 5.1 of "Guide Specification for Concrete Subject to Alkali-Silica Reactions" (2007 Portland Cement Association). Alternatively, submit ASTM C1567 test reports indicating that the combination of mix ingredients reduces the expansion due to Alkali aggregate reactivity such that the mix complies with section 5.2 of "Guide Specification for Concrete Subject to Alkali-Silica Reactions" (2007 Portland Cement Association). All tests for submitted reports shall have been performed within one year of the submittal date.
- C. Minutes of preinstallation conference.
- D. Placement Notification: Submit notification to Architect at least 24 hours in advance of placement.
- E. Certification of chloride screen effectiveness for penetrating sealers.
- F. Proposed location of saw cut joints not indicated on Drawings.
- G. Curing compound data demonstrating specified moisture loss performance.
- H. Evaporative retarder product and application data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 2. Personnel performing laboratory tests shall be 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.
3. Personnel inspecting concrete reinforcing steel have current certification as an ACI Concrete Construction Inspector or have experience in concrete construction acceptable to the Architect.
 - D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
 - E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."
 - F. Formwork: Contractor shall be responsible for design and engineering of formwork. Design of formwork and preparation of formwork drawings shall be performed under supervision of a qualified engineer registered in the state of the project.
 - G. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 - H. Preinstallation Conference: Conduct conference at Project site [~~Insert location~~].
 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Ready-mix concrete manufacturer.
 - c. Concrete subcontractor.
 - d. Special concrete finish subcontractor.
 - e. Owner's Testing/Inspection Agency.
 2. Review as applicable to Project special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.
 3. Minutes of the meeting shall be recorded by Contractor and distributed to all parties within five days. Provide one copy to Owner's representative and Architect.

- I. Record of Work: Maintain a record listing time and date of all structural concrete placement. Such record shall be kept until completion of Project and shall be available to Architect for examination at any time.
- J. Pre-Placement Inspection: Formwork installation, reinforcing steel placement and installation of all items to be embedded or cast into concrete shall be verified by Contractor prior to placement.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement if present.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Plywood, metal, or other approved panel materials.
 - 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. High-density overlay, Class 1 or better.
 - b. Medium-density overlay, Class 1 or better; mill-release agent treated, and edge sealed.
 - c. Structural 1, B-B or better; mill oiled, and edge sealed.
 - d. B-B (Concrete Form), Class 1 or better; mill oiled, and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch minimum.
- D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- E. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

- F. Form Ties: Factory-fabricated, removable, or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that will leave no corrodible metal closer than 1 1/2" inch to the plane of exposed concrete surface.
 2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.2 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- C. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed, where welding of reinforcement or field bending is noted on Drawings.
- D. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 ASTM A 706/A 706M for bars that may be field bent, deformed bars, ASTM A 775/A 775M or ASTM A 934/A 934M for bars that are prefabricated, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.
- E. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
- F. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, as-drawn, plain steel wire, with less than 2 percent damaged coating in each 12-inch wire length.
- G. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.
- H. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain steel.

2.3 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, ASTM A 775/A 775M epoxy coated.

- C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.
- D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I/II, gray- Alternate cementitious materials when proposed to control alkali-silica reactions and tested as part of a representative concrete mix in accordance with ASTM C1567, may be used subject to approval. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F or C.
- B. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials. All coarse and fine aggregate shall be tested per ASTM C 295 or ASTM C 1293 in accordance with section 5.1 of "Guide Specification for Concrete Subject to Alkali-Silica Reactions" (2007 Portland Cement Association).
 - 1. Maximum Coarse-Aggregate Size: As indicated on Drawings.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M and potable.

2.5 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those

permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. 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 CN-CI.
 - b. BASF Construction Chemicals - Building Systems; Rheocrete CNI.
 - c. Euclid Chemical Company (The), an RPM company; ARRMATECT, EUCON BCN, or EUCON CIA.
 - d. Grace Construction Products, W. R. Grace & Co.; DCI.
 - e. Sika Corporation; Sika CNI.

2.6 FIBER REINFORCEMENT

- A. Synthetic Macro-Fiber: Polyolefin macro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1 to 2-1/4 inches.

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.

- q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
 - r. Unitex; PRO-FILM.
 - s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating. Film must chemically break down in a four to six week six-week period. Provide data from independent laboratory indicating maximum moisture less than 0.30 kg/m² at 72 hours when tested in accordance with ASTM C 156.
- F. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A. Shall have test data from an independent laboratory indicating a maximum moisture less than 0.30 kg/m² at 72 hours when tested in accordance with ASTM C 156.

2.8 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber
- B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.9 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
- 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.

- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
 4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

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, according to ACI 301.
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: 25 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to ~~0.06 for post-tensioned concrete~~, 0.15 for reinforced concrete exposed to chlorides in service, 0.30 for other reinforced concrete, and 1.00 for reinforced concrete that will be dry and protected from moisture in service, percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

2.11 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Proportion structural normal-weight concrete mixture as noted on Drawings, unless aggregates are “potentially reactive” with alkalis based on the ASTM C 295 or ASTM C 1260 or ASTM C 1293 testing limits of Section 5.1 of “Guide Specification of Concrete Subject to Alkali-Silica Reactions” (2007 Portland Cement Association). When aggregates are “potentially reactive”, compliance with Section 5.2 of “Guide Specification for Concrete Subject to Alkali-Silica Reactions” (2007 Portland Cement Association) must be established through ASTM C 1567 testing for proposed alternate concrete mixture. Submit test reports in accordance with Part I of this Specification.

2.12 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M and furnish batch ticket information.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117. Concrete adjacent to elevator hoistway shall be installed to tolerances required by elevator manufacturer.
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
 - 2. Class B, 1/4 inch for rough-formed finished surfaces.
 - 3. The permissible irregularity is a cumulative value due to all sources including layout, plumbness, member size, formwork offsets, joints, and member levelness. The permissible irregularity shall also apply between adjacent concrete surfaces on opposite sides of construction joint, expansion joint or shrinkage pour strip if present.
- D. Construct forms tight enough to prevent loss of concrete mortar.

- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 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. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303 "Code of Standard Practice for Steel Buildings and Bridges."
 - a. Tolerance of Embedded Items: Comply with ACI 117.
 - 1) Anchor Rods:
 - a) Plumbness: Within +/- 1/16 inch over anchor rod projection.
 - 2) Embedded Plates and Weldments:
 - a) Location: +/- 1 inch vertical, +/- 1 inch-horizontal.

- b) Plumb and Alignment: 1/4 inch in 12 inches (1:48).
- 2. 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. Install dovetail anchor slots in concrete structures as indicated. Where masonry or veneer intersects concrete, provide one vertical dovetail slot for each 8 inches of masonry thickness. Where concrete serves as the backup, space slots at 16 inches on center.

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of walls, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
 - 1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.
- D. Size, length, number, and placement of supports shall be sufficient as to maintain reinforcing position within specified tolerances during construction traffic and concrete placement.

- E. On vertical formwork, use approved bar chairs or spacers as required to maintain concrete cover and bar position. Do not staple or use any other metallic fastener to secure bolsters, chairs, etc. to formwork for concrete surfaces exposed to exterior.
- F. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- G. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- H. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

3.5 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
 - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 - 3. Space vertical joints in walls as indicated. Locate joints beside pilasters integral with walls, near corners, and in concealed locations where possible. Locate at centerline of support or middle third of span.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
 - 3. Interior Slabs-on-Grade to Receive Carpet or Wood Floor Covering: Construct slabs as large a placement area as practical. Unless noted otherwise on Drawings, locate construction joints on column centerlines. Provide control joints at column centerlines and at intervals not more than 30 feet each way.

4. All Other Interior Slabs-on-Grade: Unless noted otherwise on Drawings, locate construction joints on column centerlines. Locate control joints where shown on Drawings. If not shown, provide control joints at column centerlines and at intervals not more than 10 feet each way.
- D. Isolation Joints in Slabs-on-Grade: 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.
 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Joints in Slabs-on-Metal Deck: Locate construction joints as shown on Drawings. For slabs with welded wire reinforcing, continue reinforcing through construction joint and lap in adjacent pour. For slabs without welded wire reinforcing, provide #4 bar 4 feet in length spaced at 12 inches on center staggered along the joint. Do not provide control joints.
- F. Topping Slabs Exposed to View: Locate control joints where shown on the Contract Drawings. If not shown, locate topping slab control joints at column centerlines, over girders and at intervals not more than 10 feet each way.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. 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.
- D. 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. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - a. Slabs supported by metal deck shall be gaged to provide the specified slab thickness over beams.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- F. Hot-Weather Placement: Comply with ACI 301 and as follows:
1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.7 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to public view otherwise indicated.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to public view.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
 - 1. Apply scratch finish to surfaces to receive concrete floor toppings.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces indicated to receive trowel finish.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated 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.
 2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
 - a. 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; for slabs-on-grade.
 - b. Specified overall values of flatness, F(F) 30; and no limit for levelness, F(L); with minimum local values of flatness, F(F) 24; and of no limit for levelness, F(L); for suspended slabs supported by metal deck under the outdoor ice rink.
- E. Broom Finish: Apply a broom finish to interior concrete landings platforms, steps, ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.9 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. 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: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.10 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 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 before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape. Moisture-retaining-cover shall be inspected each day by Contractor. Any areas which do not show condensation on underside of cover or any slab areas which are not wet shall be immediately rewetted and cover replaced to prevent moisture loss.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.
 - 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written

instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.11 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning and that are unacceptable to Architect. Allow Architect and Structural Engineer to observe concrete surfaces upon removal of forms and prior to repair of surface defects. Defects in structural concrete shall be brought to the attention of the Architect and Structural Engineer.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. 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 will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template. Submit proposed repair to Architect for review prior to commencement of work.
 - 1. Repair finished surfaces containing defects that are unacceptable to Architect. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 - 2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 6. 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. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.12 FIELD QUALITY CONTROL

- A. Testing and Inspection: As indicated on Drawings.

3.13 PROTECTION OF LIQUID FLOOR TREATMENTS

- A. 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.

END OF SECTION 03 30 00

SECTION 033000.01 - CAST-IN-PLACE CONCRETE - LANDSCAPE

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:
 - a. Planter walls
 - b. Stairs
 - c. Bench footings
 - d. Footings
 - e. Slabs

- B. Related Requirements:

- 1. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
- 2. Section 321313 "Concrete Paving" for concrete slabs.

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. Concrete repair procedures.
 - m. Concrete protection.
 - n. Initial curing and field curing of field test cylinders ASTM C31.
 - o. 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. Vapor retarders.
10. Curing materials.
11. Joint fillers.
12. 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. Intended placement method.
13. 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 sandscape finish.

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. Curing compounds.
 4. Bonding agents.
 5. Vapor retarders.
 6. Semirigid joint filler.
 7. Joint-filler strips.
 8. Repair materials.
- C. Material Test Reports: For the following, from a qualified testing agency:
1. Portland cement.
 2. Aggregates.
 3. Admixtures:
 - a. Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.
- D. 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.
- E. Preconstruction Test Reports: For each mix design.
- F. Field quality-control reports.
- G. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician 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. Mockups: Cast concrete formed-surface planter walls and steps to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.
 - 1. 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.

1.10 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.
 - 1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 3. Do not use frozen materials or materials containing ice or snow.

4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
 5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:
1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

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

2.2 CONCRETE MATERIALS

- A. Source Limitations:
1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
 2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
 3. Obtain aggregate from single source.
 4. Obtain each type of admixture from single source from single manufacturer.
- B. Cementitious Materials:
1. Portland Cement: ASTM C150/C150M, Type I/II, gray.
 2. Fly Ash: ASTM C618, Class C or F.
 3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
- C. Normal-Weight Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.
1. Alkali-Silica Reaction: Comply with one of the following:
 - a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
 - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.

- c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.
 - 2. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
 - 3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
 - 4. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 - 5. Retarding Admixture: ASTM C494/C494M, Type B.
 - 6. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
 - 7. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 - 8. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
 - 9. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
- D. Water and Water Used to Make Ice: ASTM C94/C94M, potable.

2.3 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Water: Potable or complying with ASTM C1602/C1602M.
- C. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ChemMasters, Inc.

2.4 Dayton Superior. RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.
- B. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.5 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
 4. Compressive Strength: Not less than 4100 psi at 28 days when tested in accordance with ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
 4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.6 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.
1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- 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.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs, and concrete with a w/cm below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

2.7 CONCRETE MIXTURES

A. Class A: Normal-weight concrete used for footings and topping slabs.

1. Exposure Class: ACI 318 F3.
2. Minimum Compressive Strength 4500 psi at 28 days.
3. Maximum w/cm: 0.45 .
4. Slump Limit: 4 inches , plus or minus 1 inch .
5. Slump Flow Limit: 22 inches , plus or minus 1.5 inches .
6. Air Content:
 - a. Exposure Classes F2 and F3: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.
 - b. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement

2.8 CONCRETE MIXING

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

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

3.2 PREPARATION

- ### **A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:**
1. Daily access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.

3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.
 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
 3. Install dovetail anchor slots in concrete structures as indicated. Where masonry intersects concrete, provide one vertical dovetail slot for each 8 inches of masonry thickness. Where concrete serves as the backup, space slots at 16 inches on center.

3.4 JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with 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 slabs.
 3. Space vertical joints in walls as indicated on Drawings. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
 4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
 1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.
- D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
 2. 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.

3.5 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
 2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
1. If a section cannot be placed continuously, provide construction joints as indicated.
 2. Deposit concrete to avoid segregation.
 3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.

4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
 - a. Do not use vibrators to transport concrete inside forms.
 - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
 - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
 - d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- E. Deposit and consolidate concrete for 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.

3.6 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
 - a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
 - b. Remove projections larger than 1 inch.
 - c. Tie holes do not require patching.
 - d. Surface Tolerance: ACI 117 Class D.
 - e. Apply to concrete surfaces not exposed to public view.
2. ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
 - a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
 - b. Remove projections larger than 1/4 inch.
 - c. Patch tie holes.
 - d. Surface Tolerance: ACI 117 Class B.
 - e. Locations: Apply to concrete surfaces exposed to public view.

3. ACI 301 Surface Finish SF-3.0:
 - a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
 - b. Remove projections larger than 1/8 inch.
 - c. Patch tie holes.
 - d. Surface Tolerance: ACI 117 Class A.
 - e. Locations: Apply to concrete surfaces exposed to public view.

B. Formed Finishes:

1. Sandstone finish for exterior (visible) planter walls equal to Colorado Hardscapes' Sandstone finish.
 - a. Color: Capitol Hill
2. All concrete shall be performed under the supervision of a craftsman who has completed the American Concrete Institute (ACI) Concrete Flatwork Finisher and Technician (ACICFFT) training and has five years of experience installing sand finish.
3. The concrete shall be placed and screeded to the finished grade and floated to a uniform surface using standard finishing techniques.
4. All sandstone finish should be finished using Day1 finishing aid per manufacturer's written instructions.
5. All sandstone finish curb/wall work to be installed using smooth forms, stripped while concrete is workable and troweled smooth.
6. Surface retarder will be applied and cleaned off with proper equipment.
7. Finish shall match approved site sample.

C. Related Unformed Surfaces:

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

3.7 FINISHING SLABS

- A. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish with Architect before application.

3.8 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 as indicated on Drawings.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
4. Prior to pouring concrete, place and secure anchorage devices.
 - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - b. Cast anchor-bolt insert into bases.
 - c. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.9 CONCRETE CURING

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

1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h, before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.

2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
 - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
 - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
 - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
 - d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
 - e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 1) Recoat areas subject to heavy rainfall within three hours after initial application.
 - 2) Maintain continuity of coating and repair damage during curing period.

3.10 TOLERANCES

- A. Conform to ACI 117.

3.11 JOINT FILLING

- A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.
1. Defer joint filling until concrete has aged at least one month.
 2. Do not fill joints until construction traffic has ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.
- D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.12 CONCRETE SURFACE REPAIRS

- A. Defective Concrete:
1. Repair and patch defective areas when approved by Architect.

2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.
 - a. Limit cut depth to 3/4 inch.
 - b. Make edges of cuts perpendicular to concrete surface.
 - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
 - d. Fill and compact with patching mortar before bonding agent has dried.
 - e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
 - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
 - b. Compact mortar in place and strike off slightly higher than surrounding surface.
 3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces:
 1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
 - a. Correct low and high areas.
 - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 3. After concrete has cured at least 14 days, correct high areas by grinding.
 4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.

- a. Finish repaired areas to blend into adjacent concrete.

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
 1. Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
 2. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
 3. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
 - a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
 - 1) Project name.
 - 2) Name of testing agency.
 - 3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
 - 4) Name of concrete manufacturer.
 - 5) Date and time of inspection, sampling, and field testing.
 - 6) Date and time of concrete placement.
 - 7) Location in Work of concrete represented by samples.
 - 8) Date and time sample was obtained.
 - 9) Truck and batch ticket numbers.
 - 10) Design compressive strength at 28 days.
 - 11) Concrete mixture designation, proportions, and materials.
 - 12) Field test results.
 - 13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
 - 14) Type of fracture and compressive break strengths at seven days and 28 days.
- B. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. Yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
 - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C143/C143M:
 - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - b. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete.
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M:
 - a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C31/C31M:
 - a. Cast and laboratory cure two sets of two 4-inch by 8-inch cylinder specimens for each composite sample.
 - b. Cast, initial cure, and field cure two sets of two standard cylinder specimens for each composite sample.
6. 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. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
7. 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.
8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.

9. 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.
10. Additional Tests:
 - a. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
 - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
 - 1) Acceptance criteria for concrete strength shall be in accordance with ACI 301, section 1.6.6.3.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.14 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit use of pipe-cutting machinery over concrete surfaces.
4. Prohibit placement of steel items on concrete surfaces.
5. Prohibit use of acids or acidic detergents over concrete surfaces.

END OF SECTION 033000.01

SECTION 03 37 13 - SHOTCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Concrete work including reinforcing, Division 3 Section "Cast-in-Place Concrete".

1.2 SUMMARY

- A. This Section includes shotcrete applied by wet-mix process.

1.3 DEFINITIONS

- A. Shotcrete: Mortar or concrete pneumatically projected onto a surface at high velocity.
- B. Wet-Mix Shotcrete: Shotcrete with ingredients, including mixing water, mixed before introduction into delivery hose.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.5 ACTION SUBMITTALS

- A. Product Data: For manufactured materials and products including reinforcement and forming accessories, shotcrete materials, admixtures, and curing compounds.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - a. 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. Design Mixtures for Credit ID 1.1: For each shotcrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements, and for equivalent shotcrete mixtures that do not contain portland cement replacements.
- C. Design Mixtures: For each shotcrete mix. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- D. Shop Drawings: For shotcrete installation. Include support and anchor details; reinforcement materials and grades and details of fabricating, bending, and placing reinforcement; number and location of splices; special reinforcement required for openings through shotcrete structures; and locations of proposed construction joints.
- E. Samples: For each exposed product and for each color and finish specified, approximately 24 by 24 by 2 inches in size. A mockup coordinated with the Architect may also be acceptable in lieu of a sample. Refer to section 1.7D.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and Nozzleman.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer employing nozzle operators for the Project, each of whom attains mean core grades not exceeding 2.5, according to ACI 506.2, on preconstruction tests and is ACI Shotcrete Nozzleman certified in Wet-Mix Process for Vertical and Overhead Positions as appropriate to the required shotcrete work.
- B. ACI Publications: Comply with provisions of the following unless more stringent requirements are indicated or unless modified by requirements in the Contract Documents:
1. ACI 506.2, "Specification for Shotcrete."
 2. ACI 301, "Specifications for Structural Concrete."
- C. Shotcrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design shotcrete mixtures.

- D. Mockups: Before installing shotcrete, build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undamaged at time of Substantial Completion.
 2. Build mockups for each finish required and for each design mixture, shooting orientation, and nozzle operator.
 3. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
 4. Demonstrate curing and protecting of shotcrete, finishes, and joints, as applicable.
 5. In presence of Architect, damage part of the exposed-face surface for each color and finish, and demonstrate materials and techniques proposed for repair of holes and surface blemishes to match adjacent undamaged surfaces.

1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing and inspections indicated below:
1. Produce shotcrete test panels before shotcrete placement according to requirements in ACI 506.2 and ASTM C 1140 for each design mixture, shooting orientation, and nozzle operator. Produce test panels with dimensions of 18 by 18 inches. The panel thickness and reinforcing shall reproduce the thickest and most congested area of shotcrete work on the project. Contractor shall submit proposed test panel size, thickness, and reinforcing two weeks prior to test panel construction for approval. After the test panels have been shotcreted using the same nozzleman that will be used on project, an approved curing compound shall be applied or other approved curing method shall be performed to prevent moisture loss. The test panels shall remain in their fabrication positions for at least 20 hours before being moved to the testing facility where the panels shall be moist cured until cored and tested. Such field samples shall be prepared and field cured at the contractor's expense. Additional test panels shall be made and tested if specified results are not met.
 - a. Four unreinforced cores shall be obtained from each panel for compressive strength test. The following minimum strength shall apply:
 - 1) Cores: Test per ASTM C42/C42M: Two cores at each age
 - 7 days: Required average strength = $0.75 \times f'_c$
 - 28 days: Required average strength = $0.85 \times f'_c$
 - Required minimum strength = $0.75 \times f'_c$
 - 2) Laboratory testing and reporting will be paid by Owner.

- b. Three reinforced cores, 50 in² in area, shall be taken from each panel. Visually grade the reinforced cores for compliance with specified grade.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Forms: Form-facing panels that will provide continuous, straight, smooth, concrete surfaces. Furnish panels in largest practical sizes to minimize number of joints.

2.2 REINFORCING MATERIALS

- A. Reference section 033000 for requirements.
- B. Maximum size of reinforcement as indicated.
- C. Minimum clearance between parallel reinforcement bars shall be 2 ½ inches.

2.3 SHOTCRETE MATERIALS

- A. Reference Section 033000 and structural concrete mix requirements on the structural (S series) drawings.

2.4 ADMIXTURES

- A. Reference Section 033000 for requirements.

2.5 CURING MATERIALS

- A. Reference Section 033000 for requirements.

2.6 SHOTCRETE MIXTURES, GENERAL

- A. ASTM A153/A, Class C. Reference Section 033000 and structural concrete mix requirements on the structural (S series) drawings.

2.7 SHOTCRETE MIXTURES

- A. Shotcrete Mixture: Proportion wet mixtures according to ACI 211.1 and ACI 301 using materials to be used on Project, provide shotcrete with the following properties:
 - 1. Compressive Strength (28 Days): As indicated.

2.8 SHOTCRETE EQUIPMENT

- A. Mixing Equipment: Capable of thoroughly mixing shotcrete materials in sufficient quantities to maintain continuous placement.
- B. Wet-Mix Delivery Equipment: Capable of discharging aggregate-cement-water mixture accurately, uniformly, and continuously.

2.9 BATCHING AND MIXING

- A. Wet-Mix Process: Measure, batch, mix, and deliver shotcrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M and furnish batch ticket information.

PART 3 - EXECUTION

3.1 PREPARATION

- A. The limits of each placement shall be predetermined by the contractor and shall be acceptable to the owner's representative. All shotcrete with such limits shall be placed in one continuous operation. Preparation and placement shall be as specified in ACI 506.2, unless otherwise specified.
- B. Concrete or Masonry: Before applying shotcrete, remove unsound or loose materials and contaminants that may inhibit shotcrete bonding. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces to saturated, surface-dry condition before shotcreting.
 - 1. Abrasive blast or hydroblast existing surfaces that do not require chipping to remove paint, oil, grease, or other contaminants and to provide roughened surface for proper shotcrete bonding.
- C. Earth: Compact and trim to line and grade before placing shotcrete. Do not place shotcrete on frozen surfaces. Dampen surfaces to saturated, surface-dry condition before shotcreting.

- D. Rock: Clean rock surfaces of loose materials, mud, and other foreign matter that might weaken shotcrete bonding. Dampen surfaces to saturated, surface-dry condition before shotcreting.
- E. Steel: Clean steel surfaces by abrasive blasting according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

3.2 FORMS

- A. General: Design, erect, support, brace, and maintain forms, according to ACI 301, to support shotcrete and construction loads and to facilitate shotcreting. Construct forms so shotcrete members and structures are secured to prevent excessive vibration or deflection during shotcreting.
 - 1. Fabricate forms to be readily removable without impact, shock, or damage to shotcrete surfaces and adjacent materials.
 - 2. Construct forms to required sizes, shapes, lines, and dimensions using ground wires and depth gages to obtain accurate alignment, location, and grades in finished structures. Construct forms to prevent mortar leakage but permit escape of air and rebound during shotcreting. Provide for openings, offsets, blocking, screeds, anchorages, inserts, and other features required in the Work.
- B. Form openings, chases, recesses, bulkheads, keyways, and screeds in formwork. Determine sizes and locations from trades providing such items. Accurately place and securely support items built into forms.

3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that weaken shotcrete bonding.
- C. Securely embed reinforcing anchors into existing substrates, located as required.
- D. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports, bolsters, chairs, spacers, and other devices as required to maintain specified concrete cover.
- E. Set wire ties with ends directed into shotcrete, not toward exposed shotcrete surfaces.
- F. Lap splices of reinforcing bars shall be by the noncontact lap splice method with a minimum clearance of 2 inches between bars. The use of contact lap splices may be used provided it can be demonstrated by means of preconstruction test panels that adequate encasement of bars will

be achieved, and provided that the splice is oriented so that a plane through the center of the spliced bars is perpendicular to the surface of the shotcrete.

- G. Install welded wire reinforcement in longest practical lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.4 JOINTS

- A. General: Construct joints at locations indicated or as approved by Architect.
- B. Construction Joints: Locate and install construction joints square and perpendicular to main reinforcement. Continue reinforcement through construction joints unless otherwise indicated.

3.5 ALIGNMENT CONTROL

- A. Ground Wires: Install ground wires to establish thickness and planes of shotcrete surfaces. Install ground wires at corners and offsets not established by forms. Pull ground wires taut and position adjustment devices to permit additional tightening.

3.6 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by shotcrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.7 APPLICATION

- A. Apply temporary protective coverings and protect adjacent surfaces against deposit of rebound and overspray or impact from nozzle stream.
- B. Moisten wood forms immediately before placing shotcrete where form coatings are not used.
- C. Apply shotcrete according to ACI 506.2.
- D. Apply wet-mix shotcrete materials within 90 minutes after batching.
- E. Deposit shotcrete continuously in multiple passes, to required thickness, without cold joints and laminations developing. Place shotcrete with nozzle held perpendicular to receiving surface. Begin shotcreting in corners and recesses.

1. Remove and dispose of rebound and overspray materials during shotcreting to maintain clean surfaces and to prevent rebound entrapment.
- F. Maintain reinforcement in position during shotcreting. Place shotcrete to completely encase reinforcement and other embedded items. Maintain steel reinforcement free of overspray, and prevent buildup against front face during shotcreting.
- G. Do not place subsequent lifts until previous lift of shotcrete is capable of supporting new shotcrete.
- H. Do not permit shotcrete to sag, slough, or dislodge.
- I. Remove hardened overspray, rebound, and laitance from shotcrete surfaces to receive additional layers of shotcrete; dampen surfaces before shotcreting.
- J. Do not disturb shotcrete surfaces before beginning finishing operations.
- K. Remove ground wires or other alignment-control devices after shotcrete placement.
- L. Shotcrete Core Grade: Apply shotcrete to achieve mean core grades not exceeding 2.5 according to ACI 506.2, with no single core grade exceeding 3.0.
- M. Installation Tolerances: Place shotcrete without exceeding installation tolerances permitted by ACI 117, increased by a factor of two.
- N. Cold-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 306.1 and as follows. Protect shotcrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 1. Discontinue shotcreting when ambient temperature is 40 deg F and falling.
 2. Uniformly heat water and aggregates before mixing to obtain a shotcrete shooting temperature of not less than 50 deg F and not more than 90 deg F.
 3. Do not use frozen materials or materials containing ice or snow.
 4. Do not place shotcrete on frozen surfaces or surfaces containing frozen materials.
 5. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
- O. Hot-Weather Shotcreting: Mix, place, and protect shotcrete according to recommendations of ACI 305R when hot-weather conditions and high temperatures would seriously impair quality and strength of shotcrete, and as follows:
 1. Cool ingredients before mixing to maintain shotcrete temperature at time of placement below 90 deg F for wet mix.
 2. Reduce temperature of reinforcing steel and receiving surfaces below 100 deg F before shotcreting.

3.8 SURFACE FINISHES

- A. General: Finish shotcrete according to descriptions in ACI 506R.
- B. Natural Finishes:
 - 1. Gun Finish: Natural undisturbed finish as sprayed.
 - 2. Rod Finish: Rough-textured finish obtained by screeding or cutting exposed face of shotcrete to plane with cutting rod, edge of trowel, or straightedge after initial set. Do not push or float with flat part of trowel.
 - 3. Broom Finish: Rough-textured finish obtained by screeding or cutting exposed face of shotcrete to plane with cutting rod, edge of trowel, or straightedge after initial set; followed by uniform brooming.
 - 4. Where finishes are not shown on drawings provide broom finish.

3.9 CURING

- A. Protect freshly placed shotcrete from premature drying and excessive cold or hot temperatures.
- B. Begin curing immediately after placing and finishing but not before free water, if any, has disappeared from shotcrete surface.
- C. Curing Exposed Surfaces: Cure shotcrete by one of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Water-saturated absorptive covers or moisture-retaining covers. Lap and seal sides and ends of covers with 12-inch lap over adjacent covers.
 - 2. Curing Compound: Apply uniformly in continuous operation by power spray according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Apply curing compound to natural gun finish or flash-coat shotcrete at rate of 1 gal./100 sq. ft.
- D. Curing Formed Surfaces: Cure formed shotcrete surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

3.10 FORM REMOVAL

- A. Forms not supporting weight of shotcrete may be removed after curing for 24 consecutive hours at not less than 50 deg F, provided shotcrete is hard enough not to be damaged by form-removal operations and provided curing and protecting operations are maintained.
 - 1. Leave forms supporting weight of shotcrete in place until shotcrete has attained design compressive strength. Determine compressive strength of in-place shotcrete by testing representative field-cured specimens of shotcrete.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing materials are unacceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

3.11 FIELD QUALITY CONTROL

- A. Testing and Inspection: As indicated on drawings.

3.12 REPAIRS

- A. Remove and replace shotcrete that is delaminated or exhibits laminations, voids, or sand/rock pockets exceeding limits for specified core grade of shotcrete.
 - 1. Remove unsound or loose materials and contaminants that may inhibit bond of shotcrete repairs.
 - 2. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders.
 - 3. Dampen surfaces and apply new shotcrete. Match adjacent color and finish.
- B. Repair core holes from in-place testing according to repair provisions in ACI 301, except do not use shotcrete. Match adjacent color and finish.

3.13 CLEANING

- A. Immediately remove and dispose of rebound and overspray materials from final shotcrete surfaces and areas not intended for shotcrete placement.

END OF SECTION 03 37 13

SECTION 04 20 10 – REINFORCED 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. Mortar and grout.
 - 3. Steel reinforcing bars.
 - 4. Masonry joint reinforcement.
 - 5. Miscellaneous masonry accessories.
- B. Related Sections:
 - 1. Section 042000 "Unit Masonry" for additional masonry requirements.
 - 2. Section 055000 "Metal Fabrications" for furnishing steel shelf angles, anchor rods, and bearing plates for unit masonry.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. Provide reinforced unit masonry that develops indicated net-area compressive strengths at 28 days, as indicated on drawings.
 - 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 Tables 1 and 2 in TMS 602/ACI 530.1/ASCE 6.

1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Contractor will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense. Materials tested shall be the same in every way to the materials used to construct this project and shall be from the same lots or batches used for constructing this project.
1. Clay Masonry Unit Test: For each type of unit required, according to ASTM C 67 for compressive strength.
 2. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
 3. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For the following:
1. Reinforcing Steel: Detail bending and placement of reinforced unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls. Drawings shall include:
 - a. 1/4" scale elevations of all walls with all openings and reinforcing shown.
 - b. Top and bottom elevations of walls and bearing elevations of all elements supported.
 - c. Size and location of all openings, pockets, embedments, and anchor bolts.
 - d. Bar sizes, location and quantities of reinforcing steel.
 - e. Location and arrangement of supporting and spacing devices.
 - f. Bending and cutting schedules.
 - g. All control joints, expansion joints and horizontal relief joints.
 - h. All other framing and/or special conditions affecting the work.

1.7 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each type and size of the following:
1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. Include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer.
 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
- B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Grout: Submit grout strength test data. Data shall be in conformance with the requirements for concrete mix designs per Division 3 section "Cast-in-place concrete."
 - a. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
 - b. For self consolidating grout, include test reports for slump flow and visual stability index (VSI) as determined by ASTM C1611.
- C. 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 Tables 1 and 2 in TMS 602/ACI 530.1/ASCE 6.

1.8 QUALITY ASSURANCE

- 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.
- C. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 latest edition unless modified by requirements in the Contract Documents.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

- A. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength as required to meet the specified prism strength, but in no case shall units be less than 1900 psi.
2. Density Classification: Lightweight unless otherwise indicated.

2.2 MASONRY LINTELS

- A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure prefabricated lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.3 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, 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.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Aggregate for Mortar: ASTM C 144.
- E. Aggregate for Grout: ASTM C 404.
- F. Water: Potable.
- G. Additives: None permitted, except as specified herein. Specifically do not lower freezing point of mortar or grout by use of calcium chloride or other antifreeze agents.

2.4 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
- B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
 1. Interior Walls: Hot-dip galvanized, carbon steel.
 2. Exterior Walls: Hot-dip galvanized, carbon, Stainless steel.
 3. Wire Size for Side Rods: As indicated on drawings
 4. Wire Size for Cross Rods: 0.148-inch diameter.
 5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

- C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.
- D. Masonry Joint Reinforcement for Multiwythe Masonry: Provide one of the following:
 - 1. Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches wide, plus 1 side rod at each wythe of masonry 4 inches wide or less.
 - 2. Tab type, ladder design, with 1 side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.
 - 3. Adjustable (two-piece) type, ladder design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.

2.5 MISCELLANEOUS ANCHORS

- A. Anchor Bolts: Headed steel bolts complying with ASTM F1554 grade 36, or ASTM A307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.6 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. For reinforced masonry, use portland cement-lime mortar.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Reinforced Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
 - 1. For masonry below grade or in contact with earth, use Type S.
 - 2. For reinforced masonry, use Type S.
 - 3. Mix cementitious materials and aggregates between 3 and 5 minutes in a mechanical batch mixer with a sufficient amount of water to produce a workable consistency. Unless acceptable, do not hand mix mortar. Maintain workability of mortar by remixing or

retempering. Discard mortar which has begun to stiffen or is not used within 2-½ hours after initial mixing.

D. Grout for Reinforced Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 7 in TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Grout shall attain a minimum compressive strength of 2000 psi at 28 days when tested in accordance with C1019.
3. Except for self-consolidating grout, mix and proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated.
4. Provide grout with a slump of 8 to 11 inches for grout heights less than 5 feet 4 inches, or 10 to 11 inches for grout lift heights greater than 5 feet 4 inches as measured according to ASTM C 143/C 143M, unless self-consolidating grout is used.
5. Self consolidating grout, if used, shall comply with the material requirements of ASTM C476; have a slump flow of 24 to 30 in as determined by ASTM C1611/C1611M; and has a Visual Stability Index (VSI) less than or equal to 1 as determined in accordance with ASTM C1611/C1611M, Appendix X.1.
6. Proportioning of self-consolidating grout at the project site is not permitted. Do not add water at the project site except in accordance with the self-consolidating grout manufacturer's recommendations.
7. Do not use admixtures unless acceptable. Field additional of admixtures is not permitted in self-consolidating grout.

PART 3 - EXECUTION

3.1 LAYING MASONRY WALLS

- A. Bond Pattern: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- B. 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.
- C. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.2 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar each side of grouted cells.

3.3 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
- 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.

3.4 CONTROL AND EXPANSION JOINTS

- A. General: Install control joint materials in reinforced unit masonry as masonry progresses, as indicated on drawings.

3.5 LINTELS

- A. Install steel lintels where indicated.
- B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

3.6 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

- B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6, latest edition.
1. Support reinforcement to prevent displacement caused by construction loads or by placement of grout or mortar, beyond the allowable tolerances.
 2. Completely embed reinforcing bars in grout.
 3. Maintain clear distance between reinforcing bars and the interior of masonry unit or formed surface of at least 1/4 inch for fine grout and 1/2 inch for coarse grout, except where cross webs of hollow units are used as supports for horizontal reinforcement.
 4. Place reinforcing bars maintaining the following minimum cover:
 - a. Masonry face exposed to earth or weather: 2 inches for bars larger than No. 5; 1½ inches for No. 5 bars or smaller.
 - b. Masonry not exposed to earth or weather: 1½ inches.
 5. Maintain minimum clear distance between parallel bars of the nominal bar size or 1 inch, whichever is greater.
 6. In columns and pilasters, maintain minimum clear distance between vertical bars of one and one-half times the nominal bar size or 1½ inches whichever is greater.
 7. Splice only where indicated on the Project Drawings, unless otherwise acceptable.
 8. Unless accepted by the Architect/Engineer, do not bend reinforcement after it is embedded in grout or mortar.
 9. Noncontact lap splices: Position bars spliced by noncontact lap splice no farther apart transversely than one-fifth the specified length of lap nor more than 8 inches.
 10. Joint reinforcement.
 - a. Place joint reinforcement so that longitudinal wires are embedded in mortar with a minimum cover of 1/2 inch when not exposed to weather or earth; or 5/8 inch when exposed to weather or earth.
 - b. Provide minimum 6 inch lap splices for joint reinforcement.
 - c. Ensure that all ends of longitudinal wires of joint reinforcement at laps are embedded in mortar or grout.
 11. Placement Tolerances
 - a. Place reinforcing bars in walls and flexural elements within a tolerance of 1/2 inch.
 - b. Place vertical bars within:
 - 1) 2 inches of the required location along the length of the wall when the wall segment length exceeds 24 inches.
 - 2) 1 inch of the required location along the length of the wall when the wall segment length does not exceed 24 inches.
 - c. If it is necessary to move bars more than one bar diameter or a distance exceeding the tolerance stated above to avoid interference with other reinforcing steel,

conduits, or embedded items, notify the Architect/Engineer for acceptance of the resulting arrangement of bars.

- d. Foundation dowels that interfere with unit webs are permitted to be bent to a maximum of 1 inch horizontally for every 6 inches of vertical height.
- C. Cleanouts: Provide cleanouts in the bottom course of masonry for each grout pour when the grout pour height exceeds 5 feet 4 inches.
1. Construct cleanouts so that the space to be grouted can be cleaned and inspected. In solid grouted masonry, space cleanouts horizontally a maximum of 32 inches on center.
 2. Construct cleanouts with an opening of sufficient size to permit removal of debris. The minimum opening dimension shall be 3 inches.
 3. After cleaning, close cleanouts with closures braced to resist grout pressure.
- D. Grout Placement
1. Placing time: Place grout within 1-1/2 hours from introducing water in the mixture and prior to initial set.
 - a. Discard site-mixed grout that does not meet the specified slump without adding water after initial mixing.
 - b. For ready-mixed grout:
 - 1) Addition of water is permitted at the time of discharge to adjust slump.
 - 2) Discard ready-mixed grout that does not meet the specified slump without adding water, other than the water that was added at the time of discharge. The time limitation is waived as long as the ready-mixed grout meets the specified slump.
 2. Confinement: Confine grout to the areas indicated on the Project Drawings. Use material to confine grout that permits bond between masonry units and mortar.
 3. Grout pour height:
 - a. Definition: The total height of masonry to be grouted prior to erection of additional masonry. A grout pour consists of one or more grout lifts.
 - b. Do not exceed the maximum grout pour height given in TMS 602/ACI 530.1/ASCE 6, Table 7.
 4. Grout lift height:
 - a. Definition: An increment of grout height within a total grout pour. A grout pour consists of one or more grout lifts.
 - b. For grout except self-consolidating grout:
 - 1) Where the following conditions are met, place grout in lifts not exceeding 12 feet 8 inches.

- a) The masonry has cured for at least 4 hours.
 - b) The grout slump is maintained between 10 and 11 inches.
 - c) No intermediate reinforced bond beams are placed between the top and the bottom of the pour height.
 - 2) When there are intermediate bond beams within the grout pour, limit the grout lift height to the bottom of the lowest bond beam that is more than 5 feet 4 inches (1.63 m) above the bottom of the lift, but do not exceed a grout lift height of 12 feet 8 inches.
 - 3) When the conditions above are not met, place grout in lifts not exceeding 5 feet 4 inches.
5. For self-consolidating grout:
- a. When placed in masonry that has cured for at least 4 hours, place in lifts not exceeding the grout pour height.
 - b. When placed in masonry that has not cured for at least 4 hours, place in lifts not exceeding 5 feet 4 inches.
- E. Consolidation
- 1. Consolidate grout at the time of placement.
 - a. Consolidate grout pours 12 inches or less in height by mechanical vibration or by puddling.
 - b. Consolidate pours exceeding 12 inches in height by mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred.
 - c. Consolidation or reconsolidation is not required for self-consolidating grout.
- F. Grout key: When grouting, form grout keys between grout pours. Form grout keys between grout lifts when the first lift is permitted to set prior to placement of the subsequent lift.
- 1. Form a grout key by terminating the grout a minimum of 1½ inches below a mortar joint.
 - 2. Do not form grout keys within beams.
 - 3. At beams or lintels laid with closed bottom units, terminate the grout pour at the bottom of the beam or lintel without forming a grout key.

3.7 FIELD QUALITY CONTROL

- A. As indicated on drawings.

END OF SECTION 04 20 10

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. Prefabricated building columns.
 - 3. Grout.

- B. Related Sections:

- 1. Section 014000 "Quality Requirements" for independent testing agency procedures and administrative requirements.
 - 2. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
 - 3. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
 - 4. Section 055000 "Metal Fabrications" for miscellaneous steel fabrications including steel lintels and shelf angles not attached to structural-steel frame and other metal items not defined as structural steel.
 - 5. Section 055100 "Metal Stairs."
 - 6. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for surface-preparation and priming requirements.
 - 7. Section 133419 "Metal Building Systems" for structural steel.

1.3 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- B. Heavy Sections: Rolled and built-up sections as follows:
 - 1. Shapes included in ASTM A 6/A 6M with flanges thicker than 2 inches.
 - 2. Welded built-up members with plates thicker than 2 inches.

1.4 PERFORMANCE REQUIREMENTS

- A. Refer to the Drawings for description of lateral load resisting system.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
 - 2. Laboratory Test Reports for Credit IEQ 4: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Shop and Erection Drawings: Show location, fabrication, and assembly of structural-steel components.
 - 1. Location of each piece or detail within the structure.
 - 2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 3. Include embedment piece and setting drawings.
 - 4. 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.
 - 5. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
 - 6. Drawings submitted in multiple packages shall contain individual submittals complete with all applicable erection drawings, details, and piece drawings.
 - 7. Reproduction of Contract Documents is not permitted.
 - 8. Provide schedule for submittal of shop and erection drawings.
- D. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing.
- E. Charpy V-Notch testing results for heavy sections and weld metal when required.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and fabricator.

- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill test reports for structural steel, including chemical and physical properties.
- E. Product Test Reports: For the following if present on project:
 - 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.

1.7 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement [P1] [P2] [P3] or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- E. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC 303 as amended below:
 - a. Section 3.2: Replace entire section with the following: "Requirements for structural steel including quantities, sizes, locations, arrangement, and details shall be shown or noted in the overall Contract Drawing package. Fabricator is responsible for incorporating all such information from structural, architectural, mechanical, and electrical drawings, as well as those of other disciplines."
 - b. Section 3.5: Remove all text after first sentence.
 - c. Section 3.6: Replace entire section with the following: "When the fast-track project delivery system is selected, release of structural drawings shall constitute release for construction only if specifically noted as such on the drawing. Drawing indicated "preliminary" or "not for construction" shall not be used for detailing or

construction except where the risk of any cost or delay associated with subsequent revisions to Contract Documents is accepted by the Owner, Contractor or Fabricator.”

- d. Section 4.4: Revise second sentence to read the following: “The shop and erection drawings shall be returned in accordance with the schedule defined in Division 1 of the project Specification. In the absence of such schedule, the Owner’s Designated Representative for Design shall return submittals within 14 calendar days of receipt from the Owner’s Designated Representative for Construction.”

- 2. AISC 360.
- 3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

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

1.8 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.

1.9 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' 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.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. W-Shapes: ASTM A 992/A 992M unless indicated otherwise on Drawings.
- C. Channels, Angles-Shapes: ASTM A 36/A 36M unless indicated otherwise on Drawings.
- D. Plate and Bar: ASTM A 36/A 36M unless indicated otherwise on Drawings.
- E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade C, structural tubing.
- F. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
 - 1. Weight Class: As indicated on Drawings.
 - 2. Finish: Black except where indicated to be galvanized.
- G. Welding Electrodes: Comply with AWS requirements, 70 Series
 - 1. Conform to Charpy V-Notch test requirements of AISC 360.
 - 2. Conform to Charpy V-Notch test requirements of AISC 341 for components included in the Seismic-Load-Resisting System.
- H. Heavy Sections:
 - 1. Conform to Charpy V-Notch test requirements of AISC 360.
 - 2. Conform to Charpy V-Notch test requirements of AISC 341 for components included in the Seismic-Load-Resisting System.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. Use Tension-Control, High-Strength Bolt-Nut-Washer Assemblies whenever possible unless indicated otherwise.
- B. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.
- C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Plain.
- D. Steel Headed Stud Anchors ~~Shear Connectors~~: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- E. Unheaded Anchor Rods: ASTM F 1554, Grade 55, weldable.
 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.
- F. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable, straight.
 1. Nuts: ASTM A 563 heavy-hex carbon steel.
 2. Plate Washers: ASTM A 36/A 36M carbon steel.
 3. Washers: ASTM F 436, Type 1, hardened carbon steel.
 4. Finish: Plain.
- G. Threaded Rods: ASTM A 36/A 36M.
 1. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
 2. Washers: ASTM A 36/A 36M carbon steel.
 3. Finish: Plain.
- H. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.
- I. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.
- J. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.
- K. Deformed Anchor Studs (DAS) / Deformed Bar Anchors (DBA): Made from ASTM A 108 low carbon steel, cold worked and deformed per ASTM A 496. Minimum yield stress = 60 ksi (415 MPa); minimum tensile strength = 80 ksi (550 MPa).
- L. Rebar: Rebar used for welding shall meet the requirements of ASTM A-706. Minimum bend diameters per ACI 318.
- M. Expansion Anchors, Screw Anchors, and Adhesive Anchors: Size and Manufacturer as indicated on Drawings. Complete assemblies with required rods, nuts, washers, and adhesive system as applicable. Installed in accordance with Manufacturer's installation instructions. Current ICC approval and published ICC Research Report required.

1. Finish for use in conditioned environments free from potential moisture (interior): Plain or in accordance with Manufacturer's standard.
2. Finish for use in exposed or potentially wet environments and for attachment of exterior cladding materials: Galvanized in conformance with ASTM A 153 or stainless steel, Series 300.

2.3 PRIMER

- A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Primer: Where steel is to be field painted, provide fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- C. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.4 GROUT

- A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time. Minimum compressive strength = 6000 psi.
- B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time. Minimum compressive strength = 6000 psi. Required where grout is exposed to view or weathering.

2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and 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, if applicable.

- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces. Do not enlarge bolt holes by burning.
- 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 2, "Hand Tool Cleaning or SSPC-SP 3, "Power Tool Cleaning."
- F. Steel Headed Stud Anchors and Deformed Anchor Studs / Deformed Bar Anchors ~~Shear Connectors~~: Prepare steel surfaces as recommended by manufacturer of anchors. Use automatic end welding of anchors 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 framing members.
 - 1. Cut, drill, thermal cut, or punch holes perpendicular to steel surfaces.
 - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
- H. Splices: Splicing of members to obtain required lengths is not permitted without prior approval of structural Engineer-of-Record unless indicated on the Drawings.
- I. Substitutions: Where exact sizes and weights indicated on Drawings are not readily available, secure approval of alternate sizes from Structural Engineer-of Record in time to prevent project delay.

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

2.7 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 2. Surfaces to be field welded, including top flange of beams to receive steel headed stud anchors.
 3. Surfaces to be high-strength bolted with slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 5. Galvanized surfaces.
 6. Surfaces not otherwise indicated to be painted that are not exposed to view or weather in the final condition.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to either of the following specifications and standards:
1. SSPC-SP 2, "Hand Tool Cleaning."
 2. SSPC-SP 3, "Power 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.

2.8 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
1. Fill vent and drain holes in closed sections (HSS or Pipe) that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
 2. Galvanize lintels and shelf angles located in exterior walls.

2.9 SOURCE QUALITY CONTROL

- A. Testing and Inspection: As indicated on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with 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 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.
 - 1. Coordinate installation of non-structural steel items that load the temporarily supported steel frame such that temporary supports are adequate to resist all imposed loads.
 - 2. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.
 - 3. Do not apply permanent loading other than the weight to supported concrete slab-on-deck assemblies to composite beams and girders until concrete has achieved 75 percent of its design strength without prior approval of structural Engineer-of-Record.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of baseplate where indicated on Drawings.
 - 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. Clean and moisten surfaces to receive grout. Immediately remove any remaining free water. 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's "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 will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 1. Level and plumb individual members of structure.
 2. Make allowances for difference between temperature at time of erection and mean temperature of 70° F when structure is completed and in service.
- E. Splice members only where indicated.
 1. Fasten splices in compression after bearing surface have been brought into contact. Close all gaps greater than 1/16" (2 mm) by driving non-tapered mild steel shims full depth of bearing surface along full length of gap.
- F. Do not use thermal cutting during erection unless approved by Structural Engineer-of-Record. 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. Steel Headed Stud Anchors: 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: As indicated on Drawings.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with 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 on Drawings, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.5 FIELD QUALITY CONTROL

- A. Testing and Inspection: As indicated on Drawings.

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.
- B. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" Section 099123 "Interior Painting."

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 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
 - 2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
 - 3. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
 - 4. Section 099113 "Exterior Painting" for repair painting of primed deck and finish painting of deck.
 - 5. Section 099123 "Interior Painting" for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
 - 2. Laboratory Test Reports for Credit EQ 4: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. Power-actuated mechanical fasteners.
2. Acoustical roof deck.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
- B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
- C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

- D. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 ROOF DECK

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. ASC Profiles, Inc.; a Blue Scope Steel company.
 2. Canam United States; Canam Group Inc.
 3. CMC Joist & Deck.
 4. Consolidated Systems, Inc.; Metal Dek Group.
 5. Cordeck.
 6. DACS, Inc.
 7. Epic Metals Corporation.
 8. Marlyn Steel Decks, Inc.
 9. New Millennium Building Systems, LLC.
 10. Nucor Corp.; Vulcraft Group.
 11. Roof Deck, Inc.
 12. Valley Joist; Subsidiary of EBSCO Industries, Inc.
 13. Verco Manufacturing Co.
 14. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
- 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, thickness and profile as indicated, shop primed with manufacturer's standard baked-on, rust-inhibitive primer. Use at interior locations.
 - a. Color: Manufacturer's standard.
 2. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated, G60 zinc coating. Use at exterior locations not indicated to be painted and exposed to view.
 3. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated, G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer. Use at exterior locations indicated to be painted and exposed to view.
 - a. Color: Manufacturer's standard.

4. Span Condition: As indicated.
5. Side Laps: Overlapped.

2.3 COMPOSITE FLOOR DECK

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. ASC Profiles, Inc.; a Blue Scope Steel company.
 2. Canam United States; Canam Group Inc.
 3. CMC Joist & Deck.
 4. Consolidated Systems, Inc.; Metal Dek Group.
 5. Cordeck.
 6. DACS, Inc.
 7. Epic Metals Corporation.
 8. Marlyn Steel Decks, Inc.
 9. New Millennium Building Systems, LLC.
 10. Nucor Corp.; Vulcraft Group.
 11. Roof Deck, Inc.
 12. Verco Manufacturing Co.
 13. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
- 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. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), grade, thickness and profile as indicated, with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard baked-on, rust-inhibitive primer. May be used at interior locations.
 2. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated, G60 zinc coating. May be used at interior or exterior locations not indicated to be painted and exposed to view.
 3. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated, G60 zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard baked-on, rust-inhibitive primer. Use at exterior locations indicated to be painted and exposed to view.
 4. Span Condition: As indicated.

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 indicated but not less than 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. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0747 inch thick, with factory-punched hole of 3/8-inch minimum diameter.
- H. Galvanizing Repair Paint: ASTM A 780.
- 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.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. When steel headed stud anchors are to be welded through metal deck and/or corrugated metal forming, the top flange of beams to receive such anchors shall be unpainted and free of debris prior to installation of the deck and/or forming.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
- B. Install temporary shoring before placing deck panels if required to meet deflection limitations. Obtain prior written approval from Structural Engineer-of-Record before installing shoring.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
 - 1. Refer to Drawings for opening sizes requiring reinforcement and typical reinforcement options.
 - 2. Miscellaneous openings not shown on the Drawings such as those required for vents, risers, conduits, etc. shall be cut and reinforced if necessary, by the trade requiring the opening.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck with prior written approval of Structural Engineer-of-Record. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

- A. Fasten roof-deck panels as indicated on drawings. Provide weld washer at each location where uncoated deck of thickness 0.028 inches or less is being fastened to supporting members by welding.
- B. End Bearing: Install deck ends over supporting frame with a minimum end bearing length as indicated, with end joints as follows:
 - 1. End Joints: Lapped as indicated.

- C. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, 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: As indicated, nominal.
 2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart. Steel headed stud anchors may be substituted for welds one for one in meeting spacing requirements.
 3. Weld Washers: Install weld washers at each weld location when the minimum uncoated steel thickness is less than 0.028 inches.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as follows unless otherwise indicated:
1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
 2. Mechanically clinch or button punch.
 3. Fasten with a minimum of 1-1/2-inch- long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing as indicated, with end joints as follows:
1. End Joints: As indicated.
- 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.
- F. Install piercing hanger tabs at minimum spacing indicated in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides unless otherwise indicated.
- G. Fastening Corrugated Metal Forming: Secure to supporting member with 1/2 inch minimum diameter fusion welds made through 0.0747 inch welding washers. Minimum weld requirements as follows:

1. End Laps: In valley of side laps and at center of sheet.
 2. Intermediate Supports: In valley of side lap on every other support and in valley of center corrugation on the remaining supports (to form an X pattern).
 3. Exterior Edges: 12" on center.
 4. Minimum Number of Welds Per 100 square foot of Deck Area:
 - a. 0.0164 inches thick and thinner – 25
 - b. Thicker than 0.0164 inches – 15
- H. Steel headed stud anchors shall be field welded to the structural members only after all steel framing, deck and/or forms are in place and shored when required. Deck and/or forming shall be installed such that the bottom rib plate is in continuous contact with the surface to receive anchors.
- I. Steel Headed Stud Anchor Capacity: Number of steel headed stud anchors indicated on Drawings is based on the allowable capacity for anchors in normal weight or light weight concrete as listed in AISC 360 for the composite deck specified. If additional anchors are required due to decreases in anchor capacity for the type of deck and stud placement supplied, such additional anchors shall be provided at no additional cost to the Owner.
- J. Steel Headed Stud Anchor Installation:
1. Install anchors in accordance with Manufacturer's instructions. Use only personnel and equipment authorized by the Manufacturer.
 2. Use through-deck anchor welding where deck material thickness permits proper weld fusion to develop required anchor capacity. Provide adequate test results to verify feasibility of through-deck welding for the particular anchor sizes and deck thicknesses involved.
 3. If through-deck anchor welding is not feasible, install anchors through pre-punched holes in deck. Provide pre-punched holes only where required for anchor installation and keep hole oversize to minimum required to develop a proper weld.
- K. At the beginning of each shift of work, and after each time welding equipment has been moved, two test anchors shall be installed and bent to 45 degrees by the Contractor. If failure occurs, adjust equipment and repeat test. Two consecutive test studs shall be welded and found satisfactory before production for that shift begins or is resumed.

3.5 FIELD QUALITY CONTROL

- A. Testing and Inspection: As indicated on Drawings.

3.6 PROTECTION

- A. Galvanizing Repairs: Where deck is exposed to weather or moisture, prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.
 - 1. Do not use deck units for storage or as a working platform until permanently secured in position.
 - 2. Contractor shall assure that completed deck is not damaged by use as a runaway, storage of materials or subsequent work.
 - 3. Contractor shall assure that construction loads are not allowed which exceed the safe carrying capacity of the deck.

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. This Section includes the following:
 - 1. Exterior non-load-bearing and soffit wall framing.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for masonry shelf angles and connections.
 - 2. Division 09 Section "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.
 - 3. Division 09 Section "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.
 - 1. Design Loads: As indicated.
 - 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than indicated on drawings.
 - 3. Design framing systems to provide for movement of framing members 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 indicated on drawings.

- B. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."
 - 1. Headers: Design according to AISI's "Standard for Cold-Formed Steel Framing - Header Design."
 - 2. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

1.4 SUBMITTALS

- A. Product Data: For each type of cold-formed metal framing product and accessory indicated.
- B. Shop Drawings: Provide $\frac{1}{4}" = 1'-0"$ scale elevations of all walls and plans of all soffits comprised of cold-formed metal framing. Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
 - 1. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Welding certificates.
- D. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:
 - 1. Vertical deflection clips.
 - 2. Horizontal drift deflection clips
 - 3. Stiff Clips

1.5 QUALITY ASSURANCE

- A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.
- B. 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 cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.

- C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.
- D. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."
- E. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
- F. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
 - 1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Truss Design."
 - 2. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."
- G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Allied Studco.
 - 2. AllSteel Products, Inc.
 - 3. California Expanded Metal Products Company.
 - 4. Clark Steel Framing.
 - 5. Consolidated Fabricators Corp.; Building Products Division.
 - 6. Craco Metals Manufacturing, LLC.
 - 7. Custom Stud, Inc.

8. Dale/Incor.
9. Design Shapes in Steel.
10. Dietrich Metal Framing; a Worthington Industries Company.
11. Formetal Co. Inc. (The).
12. Innovative Steel Systems.
13. MarinoWare; a division of Ware Industries.
14. Quail Run Building Materials, Inc.
15. SCAFCO Corporation.
16. Southeastern Stud & Components, Inc.
17. Steel Construction Systems.
18. Steeler, Inc.
19. Super Stud Building Products, Inc.
20. United Metal Products, Inc.

2.2 MATERIALS

- A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
 1. Grade: ST33H, 33 ksi for studs 18 gauge and lighter. ST50H.
 2. Coating: G60.
- B. Steel Sheet for Vertical Deflection Stiff Drift Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
 1. Grade: 50, Class 1 or 2. As required by structural performance.
 2. Coating: G90.
 3. Gauge: 14 gauge minimum.

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: 0.0329 inch and as indicated.
 2. Minimum Flange Width: 1-5/8 inches
 3. Section Properties: As required.
- 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 and head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dietrich Metal Framing; a Worthington Industries Company.
 - b. MarinoWare, a division of Ware Industries.
 - c. SCAFCO Corporation
 - d. The Steel Network, Inc.
- D. Maximum track lateral deflection under design load shall not exceed 1/8" or the elastic limit load.
- E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure.
- F. Stiff Clips: Clip capable of supporting design loads indicated through positive mechanical attachment to the stud web. Maximum deflection of the clip/stud assembly under design loads shall be the smaller of 1/8" or the elastic limit load.

2.4 EXTERIOR SOFFIT JOIST FRAMING

- A. Steel Soffit Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0329 inch.
 - 2. Flange Width: 1-5/8 inches, minimum.
 - 3. Section Properties: As required and as indicated.

2.5 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
 - 1. Supplementary framing.
 - 2. Bracing, bridging, and solid blocking.
 - 3. Web stiffeners.
 - 4. Anchor clips.

5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers, knee braces, and girts.
9. Joist hangers and end closures.
10. Hole reinforcing plates.
11. Backer plates.

2.6 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. Anchor Bolts: ASTM F 1554, Grade **55**, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.
- C. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
- D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.
- E. 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.
- F. Welding Electrodes: Comply with AWS standards.

2.7 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035.
- B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and

plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time.

- D. Shims: Load bearing, high-density multimonomer plastic, nonleaching.
- E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.8 FABRICATION

- A. Fabricate cold-formed metal 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 metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.
 - 4. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.
- C. Install load bearing shims or grout between the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations to ensure a uniform bearing surface on supporting concrete or masonry construction.
- D. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

- A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed metal 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 metal framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.
- H. Install insulation, specified in Division 07 Section "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.
- J. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to top and bottom track, unless otherwise indicated. Space studs as follows:
 1. Maximum Stud Spacing: 16 inches.

- 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. Connect vertical deflection clips to bypassing and infill studs and anchor to building structure.
 - 2. Connect drift clips to cold formed metal framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
 - 1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.5 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Remove and replace work where test results indicate that it does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

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BP3-Goldwalk, Promenade-
Permit and IFC

**Steamboat Base Village
Redevelopment**
Steamboat Springs, Colorado

END OF SECTION 05 40 00

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes metal fabrications and includes, but is not limited to, the following types of fabrications:
 - 1. Loose bearing and leveling plates.
 - 2. Miscellaneous framing and supports.
 - 3. CMU partition head supports.

1.2 COORDINATION

- A. Coordinate installation of anchorages for metal fabrications. 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.

1.3 ACTION SUBMITTALS

- A. Product Data: Submit product data for the following:
 - 1. Paint products.
 - 2. Grout.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Shop Drawings: Submit shop drawings detailing the fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
 - 1. For installed products indicated to comply with design loads, include structural analysis data, for information only, signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Include plans and elevations at not less than 1" to 1'-0" scale, and include details of sections and connections at not less than 3" to 1'-0" scale.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding Certificates: Copies of certificates for welding procedures and personnel.
- B. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.5 QUALITY ASSURANCE

- A. Fabricator/Installer Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project for a minimum of 5 years, with a record of successful in-service performance, with sufficient production capacity to produce required units without causing delay in the work.
- B. 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 metal fabrications that are similar to those indicated for this Project in material, design, and extent.
- C. Welding: 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."
 - 3. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store metal fabrications in a dry, well-ventilated, weathertight place. Deliver and handle so as to prevent any type of damage to the fabricated work.

1.7 FIELD CONDITIONS

- A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

- B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Exterior Metal Fabrications: All exterior metal fabrications shall be fabricated and installed to prevent buckling, opening up of joints and overstressing of welds and fasteners under the following temperature conditions:
 - 1. Base fabrication on a temperature of +70 deg F at time of installation with allowance made for an exposed metal surface temperature range of -5 deg F to +180 deg F. Make all necessary adjustments and provisions for concealed expansion.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: For metal fabrications 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.

2.3 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Cold Finished Steel Bars: ASTM A 108, grade as selected by fabricator.
- C. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) minimum, unless otherwise indicated or required to satisfy the performance requirements; finish as follows:
 - 1. Black finish, unless otherwise indicated.
- D. Slotted Channel Framing: Cold-formed metal channels with continuous slot and with flanged edges returned toward web complying with MFMA-4 and fabricated from steel complying with ASTM A 1011/A 1011M. Width, depth, and metal thickness as required to suit performance requirements.

- E. Cast-in-Place Anchors in Concrete: Anchor channel type, with filler strips, manufactured from formed hot or cold rolled carbon steel channels with flange edges returned toward web, having a minimum of 2 stud, or I, anchors shop welded to the back of each channel, complying with ASTM A 1011. Provide channels, bolts, washers, and shims hot-dip galvanized per ASTM A 153/A 153M. Width, depth, and metal thickness as required to suit performance requirements.
- F. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.4 PAINT

- A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Shop Primer for Ferrous Metal: Organic zinc-rich primer, complying with SSPC-Paint 20 and compatible with topcoat.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Carboline 621; Carboline Company.
 - b. Aquapon Zinc-Rich Primer 97-670; PPG Paints.
 - c. Tneme-Zinc 90-97; Tnemec Company, Inc.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 FASTENERS

- A. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- B. Anchor Bolts: ASTM F 1554, Grade 36.
- C. Eyebolts: ASTM A 489.
- D. Machine Screws: ASME B18.6.3.
- E. Lag Bolts: ASME B18.2.1.
- F. Wood Screws: Flat head, carbon steel, ASME B18.6.1.

- G. Plain Washers: Round, carbon steel, ASME B18.22.1.
- H. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1.
- I. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Interior Expansion Anchor Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Exterior Expansion Anchor Material: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.
- J. Toggle Bolts: FS FF-B-588, tumble-wing type, class and style as needed.

2.6 GROUT

- A. Non-shrink, Non-metallic Grout: Factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.7 CONCRETE FILL

- A. Concrete Materials and Properties: Composed of ASTM C 150 Type I Portland cement, ASTM C 33 sand and coarse aggregates and potable water to produce a low slump mix suitable for placement. Grade coarse aggregate from 1/8 inch with at least 95 percent passing a 3/8 inch sieve and not more than 10 percent passing a No. 8 sieve. Fill shall be proportioned to provide a minimum 28-day compressive strength of 3000 psi.

2.8 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. 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.
 - 1. Welded connections may be used where bolted connections are shown.
- B. Shear and punch metals cleanly and accurately. Remove burrs.
- C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

- D. Weld corners and seams continuously along entire line of contact to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices and fasteners to secure metal fabrications rigidly in place and to support indicated loads.
- F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.
- H. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- I. Remove sharp or rough areas on exposed traffic surfaces.
- J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous. Make up threaded connections tight so that threads are entirely concealed.

2.9 STEEL LADDERS

- A. General: Fabricate ladders for locations shown, with dimensions, spacings, details, and anchorages as indicated.
 - 1. Comply with ANSI A14.3, unless otherwise indicated.
- B. Siderails: Continuous, 1/2 by 2-1/2 inch steel flat bars, with eased edges, spaced 18 inches apart.
- C. Bar Rungs: 3/4 inch square steel bars, spaced 12 inches o.c.
- D. Fit rungs in centerline of side rails; plug-weld and grind smooth on outer rail faces.

- E. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets. Size brackets to support design loads specified in ANSI A14.3.
- F. Provide non-slip 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.

2.10 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 exterior plates after fabrication; prime paint interior plates after fabrication.

2.11 LOOSE STEEL LINTELS

- A. Fabricate loose structural-steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Furnish a minimum of 1 angle for each masonry wythe; provide two (2) angles at all openings in 8, 10 and 12 inch masonry walls and partitions. Unless otherwise indicated on the structural drawings furnish loose steel lintels as follows:

Max. Opening Width (Feet)	Masonry Wall and Partition Thickness (inches)			
	4	6	8	10 and 12
2	3-1/2 x 3-1/2 x 1/4	5 x 5 x 5/16	3-1/2 x 3-1/2 x 1/4	8 x 4 x 1/2
3	3-1/2 x 3-1/2 x 1/4	5 x 5 x 5/16	3-1/2 x 3-1/2 x 1/4	8 x 4 x 1/2
4	3-1/2 x 3-1/2 x 1/4	5 x 5 x 5/16	3-1/2 x 3-1/2 x 1/4	8 x 4 x 1/2
5	3-1/2 x 3-1/2 x 1/4	5 x 5 x 5/16	3-1/2 x 3-1/2 x 1/4	8 x 4 x 1/2
6	3-1/2 x 3-1/2 x 1/4	5 x 5 x 5/16	3-1/2 x 3-1/2 x 1/4	8 x 4 x 1/2
7	3-1/2 x 3-1/2 x 1/4	5 x 5 x 5/16	3-1/2 x 3-1/2 x 1/4	8 x 4 x 1/2
8	4 x 3-1/2 x 1/4	5 x 5 x 5/16	4 x 3-1/2 x 1/4	8 x 4 x 5/8

- B. Weld adjoining members together to form a single unit where indicated.
- C. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than 8 inches, unless otherwise indicated.
- D. Galvanize loose steel lintels located in exterior walls. Prime paint loose steel lintels located in interior walls.

2.12 SHELF ANGLES

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide machined horizontally slotted holes to receive 3/4 inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
- B. Provide joint gaps in angles where control and expansion joints in exterior cladding skin are shown or required. Size joint gaps to match width of the masonry joints in the location of use. Provide joints in other locations, as required for fabrication only, with tight joints.
 - 1. Provide units at corners and other transitions fabricated into one piece.
- C. Galvanize shelf angles to be installed in exterior walls; prime paint shelf angles to be installed in interior walls.

2.13 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports indicated and as necessary to complete the Work and which are not a part of the structural framework, including but not limited to framing and supports for CMU partition head supports,, and mechanical and electrical equipment.
- B. Fabricate units from structural-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 retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
- C. CMU Partition Head Supports: Fabricate supports from 4 inch by 4 inch by 1/4 inch by 36 inch long structural steel angles. Drill supports a maximum of 12 inches o.c. to receive expansion bolts.

2.14 SUMP PIT COVERS

- A. Fabricate from 3/16-inch rolled-steel floor plate with four 1-inch- diameter holes for water drainage and for lifting.
- B. Provide steel angle supports as indicated.

2.15 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from structural-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. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 6 inches from each end, 6 inches from corners, and 24 inches o.c., unless otherwise indicated.
- C. Galvanize exterior miscellaneous steel trim; prime paint interior miscellaneous steel trim.

2.16 PIPE BOLLARDS

- A. Fabricate pipe bollards from Schedule 40 steel pipe.
- B. Fabricate bollards with 3/8 inch thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4 inch anchor bolts.
 - 1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

2.17 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
 - 1. ASTM A 123/A 123M, for galvanizing steel and iron products.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces by removing oil, grease, and similar contaminants in accordance with SSPC-SP 1 "Solvent Cleaning," followed with the SSPC surface-preparation specifications listed below and environmental exposure conditions of installed metal fabrications. Surface preparation shall be done after fabrication and immediately prior to shop painting. Apply shop coat of paint within 4 hours after cleaning and before rust bloom occurs.
 - 1. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- C. Apply a minimum of one coat of shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be field welded, and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. Dry Film Thickness of Primer: 2.5 to 3.0 mils, dry film thickness. Apply paint thoroughly and evenly to dry surfaces, free from holidays and pinholes, in accordance with manufacturer's directions.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors. Drill holes for bolts to the exact diameter of the bolt. Provide screws threaded full length to the screw head.
- B. 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.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- D. 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.
- E. 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. Quality of Workmanship:
 - a. At concealed connections: No improvement from mill finish, except preparation necessary for priming is required. Welds are not required to be ground.
 - b. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness, pits, mill marks, nicks, or scratches show after finishing and contour of welded surface matches that of adjacent surface. Defects and distortions shall not be visible to the eye nor show through painted or polished surfaces.

3.2 SETTING 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 grout.
 - 1. Use non-shrink grout, either metallic or non-metallic, in concealed locations where not exposed to moisture; use non-shrink, non-metallic grout in exposed locations, unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.3 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, if any.
- B. CMU Partition Head Supports: Unless otherwise indicated place partition head supports on alternate faces of CMU partitions every 6'-0" o.c. and expansion bolt to underside of structure. Do not bolt to CMU partitions.

3.4 INSTALLING PIPE BOLLARDS

- A. Anchor bollards to existing construction with post-installed anchors and bolts. Provide four 3/4 inch anchors at each bollard, unless otherwise indicated. Embed anchors at least 4 inches in existing concrete.
- B. Fill bollards solidly with concrete, mounding top surface.

3.5 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed 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 dry film thickness.

END OF SECTION 05 50 00

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Steel framing and supports for wood bench.

- B. Products furnished, but not installed, under this Section include the following:

- 1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
 - 2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other sections. Related Requirements:
 - 3. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
 - 4. Section 061063 "Exterior Rough Carpentry" for wood bench.

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. Paint products.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
 - 1. Steel framing and supports for wood bench.
- C. Samples for Verification: For each type and finish of metal.

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."

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of concrete foundation, cast-in-place stairs, walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. 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, ambient; 180 deg F, 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. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- D. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

2.3 FASTENERS

- A. Steel Anchor Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A with hex nuts, ASTM A 563; and, where indicated, flat washers.
- B. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
- C. 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.
- D. 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.

2.4 MISCELLANEOUS MATERIALS

- A. 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. Shop Primer for Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- C. Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. 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.
- E. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

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 unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 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. Galvanize miscellaneous framing and supports where indicated.

2.7 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.

2.8 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.

2.9 STEEL 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 unless indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" requirements indicated below:
 - 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."

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. 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. 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.
- C. 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 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 dry film thickness.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055000

SECTION 05 51 00 - METAL STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Industrial-type stairs with steel grate treads.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for metal treads and nosings installed at locations other than in metal stairs.
2. Section 05 52 13 "Pipe and Tube Railings" for pipe and tube railings.

1.2 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 anchorages for metal stairs. 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. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

1.3 ACTION SUBMITTALS

A. Product Data: For metal stairs and the following:

1. Metal floor grate treads.
2. Paint products.
3. Grout.

B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."

- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show working points and column centerline locations in plan and in section. Include details of metal stairs and their connections, including stringers, treads, risers, headers, platforms, struts, hangers, supplemental steel framing for connection and alignment of threaded rod hangers to structural steel building framing, railings, handrails, guardrails, brackets, reinforcements, anchors, welded and bolted field and shop connections (size and location), and other supplemental information. Where conditions in three or more consecutive stories are exactly alike, the drawings may be broken and noted to include the duplicate runs.
1. For installed products indicated to comply with performance requirements and design criteria, submit shop drawings signed and sealed by the qualified professional engineer responsible for their preparation.
 2. Include plans and elevations at not less than 1" to 1'-0" scale, and include details of sections and connections at not less than 3" to 1'-0" scale.
- D. 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Standards: Except as modified by governing codes and the Contract Documents, comply with the applicable provisions and recommendations of the following:
1. National Association of Architectural Metal Manufacturers (NAAMM) Metal Finishes Manual• .
 2. National Association of Architectural Metal Manufacturers (NAAMM) Metal Stairs Manual• .
 3. National Ornamental & Miscellaneous Metals Association (NOMMA) Metal Rail Manual• .
- B. Fabricator/Installer Qualifications: A firm experienced in producing metal stairs similar to those indicated for this Project for a minimum of 5 years, with a record of successful in-service performance, with sufficient production capacity to produce required units without causing delay in the work.
1. Employ only experienced tradesmen for both fabrication and installation, who are capable of producing work of the highest standards of quality in the industry.

- C. 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 metal stairs (including handrails and railing systems) that are similar to those indicated for this Project in material, design, and extent.
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 FIELD CONDITIONS

- A. Field Measurements: Where metal stairs are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
 - 1. Uniform Load: 100 lbf/sq. ft..
 - 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.
 - 4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
 - 5. Limit deflection of treads, platforms, and framing members to L/720 or 1/4 inch, whichever is less.
- C. Structural Performance: Railings, including attachment to building construction, 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. applied in any direction.
 - b. Concentrated load of 200 lbf 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 applied horizontally on an area of 1 sq. ft..
- b. Infill load and other loads need not be assumed to act concurrently.

3. Deflection Criteria: The larger deflections at the top from either the horizontal live loads or applicable wind loads shall be the lesser of $3/4$ -inch or $h/90$ for cantilever elements, and $h/175$ for simple span elements, where h is the distance from the floor level to the top of guardrail. Applied loads shall be allowable stress design loads.

D. Seismic Performance: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor is 1.5.

E. Exterior Metal Fabrications: All exterior metal stairs shall be fabricated and installed to prevent buckling, opening up of joints and overstressing of welds and fasteners under the following temperature conditions:

- 1. Base fabrication on a temperature of +70 deg F at time of installation with allowance made for an exposed metal surface temperature range of -5 to +180 deg F. Make all necessary adjustments and provisions for concealed expansion.

F. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

G. Regulatory Requirements: Comply with the requirements of Part 1910 of the Occupational Safety and Health Standards (OSHA), the American Disabilities Act (ADA), and local regulatory requirements as applicable to stairs, handrails and the protection of openings; where regulatory requirements conflict the more stringent shall apply.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without pitting, seam marks, roller marks, rolled trade names, or blemishes.
- B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.3 FERROUS METALS

- A. General: Provide ferrous metal (steel and iron) in the form indicated, complying with the following requirements.

- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Steel Tubing: ASTM A 500 (cold-formed) or ASTM A 513.
- D. Steel Pipe: ASTM A 53, Type S - Seamless, Grade A suitable for close coiling or cold bending, standard weight (Schedule 40) minimum, unless otherwise indicated or required to satisfy performance requirements; finish as follows:
 - 1. Black finish, unless otherwise indicated.
 - 2. Galvanized finish for exterior installations and where indicated.
- E. Steel Bars for Gratings: ASTM A 36/A 36M.
- F. Wire Rod for Grating Crossbars: ASTM A 510.
- G. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 coating, either commercial quality or structural quality, Grade 33, unless another grade is required for performance requirements.

2.4 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
 - 1. 94-258 Series Multi-Prime Fast Dry 2.8 VOC Universal Metal Primer; Pittsburgh Paints.
 - 2. B50 Z Kem Kromik Universal Primer Fast Dry; Sherwin-Williams Co.
 - 3. Series 37H Phenolic Alkyd Primer Chem-Prime; Tnemec.
- 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.

- F. 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.

2.6 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, struts, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
 - 1. Join components by welding unless otherwise indicated.
 - 2. Use connections that maintain structural value of joined pieces.
 - 3. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.
- B. Shop Assembly: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld connections to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Weld exposed corners and seams continuously unless otherwise indicated.
 - 5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.
- H. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.7 STEEL-FRAMED STAIRS

A. Stair Framing:

1. Fabricate stringers of steel plates or channels.
 - a. Provide closures for exposed ends of channel stringers.
2. Construct platforms of steel plate or channel headers and miscellaneous framing members as indicated to comply with performance requirements.
3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
4. Where stairs are enclosed by gypsum board assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.
5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

B. Floor Grating Treads and Platforms: Form to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual for Steel Stainless Steel, and Aluminum Gratings and Stair Treads."

1. Fabricate treads and platforms from welded steel grating with 1-1/4-by-3/16-inch bearing bars at 15/16 inch o.c. and crossbars at 4 inches o.c., NAAMM designation: W-15-4 (1-1/4 x 3/16) STEEL.
2. Fabricate treads and platforms from pressure-locked steel grating with 1-by-3/16-inch bearing bars at 1/16 inch o.c. and crossbars at 4 inches o.c., NAAMM designation: P-11-4 (1 x 3/16) STEEL.
3. Surface: Plain.
4. Surface: Serrated.
5. Finish: Shop primed.
6. Finish: Painted.
7. Finish: Galvanized.
8. Fabricate grating treads with steel floor plate nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
9. Fabricate grating treads with cast abrasive nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
10. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Weld grating to platform framing.

2.8 STAIR HANDRAILS AND RAILINGS

- A. General: Comply with applicable requirements in Section 05 52 13 Pipe and Tube Railings" for handrails and railings.

2.9 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal stairs after assembly.
 - 1. Prime paint interior stairs and components unless otherwise noted.
 - 2. Fabricate all exterior stairs and components from hot dipped galvanized materials.
- C. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
 - 1. ASTM A 123, for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strips 0.0299 inch thick and heavier.
 - 2. ASTM A 153/A 153M, for galvanizing steel and iron hardware
 - 3. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- D. Preparation for Shop Priming: Prepare uncoated (non-galvanized) ferrous-metal surfaces by removing oil, grease, and similar contaminants in accordance with SSPC-SP 1 "Solvent Cleaning," followed with the SSPC surface-preparation specifications listed below. Surface preparation shall be done after fabrication and immediately prior to shop painting. Apply shop coat of paint within 4 hours after cleaning and before rust bloom occurs.
 - 1. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning".
- E. Apply a minimum of one coat of shop primer to uncoated (non-galvanized) surfaces of metal fabrications, except those to be embedded in concrete or masonry and those to be field welded, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges
 - 2. Dry Film Thickness of Primer: 2.5 to 3.0 mils, dry film thickness. Apply paint thoroughly and evenly to dry surfaces, free from holidays and pinholes, in accordance with manufacturers directions.
- F. Do not deliver metal stair work until primer has dried.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Metal Stair Installation, General: Erect stairs, railings and handrails, and infill panels square, plumb, straight and true to line and level, in the correct locations and in proper relation to adjoining work with neatly fitted joints and intersections. Installation shall be secure and rigid.
- B. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors. Drill holes for bolts to the exact diameter of the bolt. Provide screws threaded full length to the screw head.
- C. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- D. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. 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.
- G. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength 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.
- H. Leave work exposed to view, including stair soffits, clean, smooth and neatly finished.
- I. Include supplementary parts necessary to complete each item, though such work is not definitely shown or specified.

3.2 INSTALLING STEEL RAILINGS AND HANDRAILS

- A. Adjust handrails and railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by performance requirements. Plumb posts in each direction. Secure posts and railing ends to building construction as follows:
 - 1. Anchor posts to steel by welding directly to steel supporting members.
 - 2. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.
- B. Attach handrails to wall with wall brackets. Provide bracket with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to satisfy the performance requirements. Secure wall brackets to building construction as follows:
 - 1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
 - 2. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 - 3. For hollow masonry anchorage, use toggle bolts.
 - 4. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed reinforcements using self-tapping screws of size and type required to satisfy the performance requirements.

3.3 CONCRETE FILL INSTALLATION

- A. Place concrete fill into steel pan platforms and treads. Screed concrete fill level and finish with wood float. After screeding, permit concrete fill to cure until it can support the weight of workmen standing on boards.

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed 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 dry film thickness
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 51 00

SECTION 055213 - 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. Railing Type 1: At Stairs
 - 2. Railing Type 2: At Ice Rink
 - 3. Railing Type 3: Drink Ledge
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves and other items cast into concrete.

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 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.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Fasteners.
 - 3. Post-installed anchors.
 - 4. Handrail brackets.
 - 5. Shop primer.

6. Intermediate coats and topcoats.
 7. Nonshrink, nonmetallic grout.
 8. Anchoring cement.
 9. Metal finishes.
 10. Paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Initial Selection: For products involving selection of color, texture, or design.
- D. Samples for Verification: For each type of exposed finish required.
1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish.
 2. Fittings and brackets.
 3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
 - a. Show method of connecting and finishing members at intersections.
- E. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Mill Certificates: Signed by manufacturers of steel products, certifying that products furnished comply with requirements.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- E. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.
- F. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, 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. applied in any direction.
 - b. Concentrated load of 200 lbf 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 applied horizontally on an area of 1 sq. ft.
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 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.
 - 1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

2.3 STEEL RAILINGS

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Tubing: ASTM A500/A500M cold formed.
- C. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
- D. Plates, Shapes, and Bars: ASTM A36/A36M.
- E. Perforated-Metal Drink Rail surfacing:
 - 1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, or hot-rolled steel sheet, ASTM A1011/A1011M, commercial steel, Type B, 22 gauge (0.03 inch thick), with 1/4-inch square holes 3/4-inch o.c. in straight centers, 1/2 bar width, 1.78 holes per square inch, 11% open.

2.4 FASTENERS

- A. Fastener Materials:
 - 1. Ungalvanized-Steel Railing Components: Plated steel fasteners complying with ASTM F1941, Class Fe/Zn 5 for zinc coating.
 - 2. Finish exposed fasteners to match appearance, including color and texture, of railings.
- 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 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 exposed fasteners are unavoidable or are the standard fastening method for railings indicated.

- D. Post-Installed 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 AC193.

2.5 MISCELLANEOUS MATERIALS

- A.
- B. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.
 - 1. For steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- C. 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.
- D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- E. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.
- F. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.
- G. Bituminous Paint: Cold-applied asphalt emulsion, complying with ASTM D1187/D1187M.
- H. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- I. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 - 1. 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: Fabricate railings and gates 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. Shop assemble railings and gates to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.
 - 1. Clearly mark units for reassembly and coordinated installation.
 - 2. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
 - 2. 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 are exposed to weather in a manner that excludes water.
 - 1. Provide weep holes where water may accumulate.
 - 2. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded connections unless otherwise indicated.
- H. 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.
- I. Form changes in direction as follows:
 - 1. As detailed.
 - 2. By bending to smallest radius that will not result in distortion of railing member.
- J. 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.
- K. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.
- L. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

- N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.
 - 1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
 - 2. Coordinate anchorage devices with supporting structure.
- O. For removable railing posts, fabricate slip-fit sockets from stainless steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height.
 - 1. Provide socket covers designed and fabricated to resist being dislodged.
 - 2. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

2.7 STEEL FINISHES

- A. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, hot-dip galvanize anchors to be embedded in exterior concrete or masonry.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3. SSPC-SP 3. requirements indicated below:
 - 1. Exterior Railings: SSPC-SP 6/NACE No. 3.
 - 2. Railings Indicated To Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3.
 - 3. Railings Indicated To Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3.
 - 4. Other Railings: SSPC-SP 3.
- C. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
 - 1. Shop prime uncoated railings with universal shop primer unless indicated.
- D. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1 for shop painting. Apply at spreading rates recommended by coating manufacturer.
 - 1. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Perform cutting, drilling, and fitting required for installing railings.
 - 1. Fit exposed connections together to form tight, hairline joints.
 - 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
 - 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
 - 4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 5. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 6. 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.
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
 - 1. 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.
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. 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 beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within 6 inches of post.

3.3 ANCHORING POSTS

- A. Form or core-drill holes not less than 6 inches deep and 1/2 inch 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 or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Leave anchorage joint exposed with 1/8-inch buildup, sloped away from post.
- C. Install removable railing sections, where indicated, in slip-fit stainless steel sockets cast in concrete.

3.4 REPAIR

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

3.5 CLEANING

- A. Clean steel surfaces by washing thoroughly with clean water and soap and rinsing with clean water.

3.6 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

END OF SECTION 055213

SECTION 05 52 13 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel pipe and tube railings.

1.2 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.

1.3 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. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. For installed products indicated to comply with performance requirements and design criteria, submit shop drawings signed and sealed by the qualified professional engineer responsible for their preparation.

- D. 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

- A. Fabricator/Installer Qualifications: A firm experienced in producing handrails and railings similar to those indicated for this Project for a minimum of 5 years, with a record of successful in-service performance, with sufficient production capacity to produce required units without causing delay in the work.
 - 1. Employ only experienced tradesmen for both fabrication and installation, who are capable of producing work of the highest standards of quality in the industry.
- B. 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 handrails and railings that are similar to those indicated for this Project in material, design, and extent.
- C. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 STORAGE, DELIVERY AND HANDLING

- A. Store railings in a dry, well-ventilated, weathertight place. Deliver and handle so as to prevent any type of damage to the fabricated work.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with pipe and tube railings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating railings without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 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, including attachment to building construction, 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. applied in any direction.
 - b. Concentrated load of 200 lbf 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 applied horizontally on an area of 1 sq. ft..
 - b. Infill load and other loads need not be assumed to act concurrently.
 3. Deflection Criteria: The larger deflections at the top from either the horizontal live loads or applicable wind loads shall be the lesser of 3/4-inch or $h/90$ for cantilever elements, and $h/175$ for simple span elements, where h is the distance from the floor level to the top of guardrail. Applied loads shall be allowable stress design loads.
- D. Exterior Metal Fabrications: All exterior metal stairs shall be fabricated and installed to prevent buckling, opening up of joints and overstressing of welds and fasteners under the following temperature conditions:
 1. Base fabrication on a temperature of +70 deg F at time of installation with allowance made for an exposed metal surface temperature range of -5 to +180 deg F.
 - . Make all necessary adjustments and provisions for concealed expansion.

- E. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
- F. Regulatory Requirements: Comply with the requirements of Part 1910 of the Occupational Safety and Health Standards (OSHA), the American Disabilities Act (ADA), and local regulatory requirements as applicable to stairs, handrails and the protection of openings; where regulatory requirements conflict the more stringent shall apply.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without pitting, seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes where exposed to view on finished units.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
- C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.3 STEEL AND IRON

- A. General: Provide steel and iron (ferrous metal) in the form indicated, complying with the following requirements.
- B. Pipe: ASTM A 53/A 53M, Type S “” Seamless, Grade A, suitable for close coiling or cold bending, Standard Weight (Schedule 40) minimum, unless another grade and weight are required to suit performance requirements.
 - 1. Galvanized finish unless otherwise indicated.
- C. Tubing: ASTM A 500 (cold formed) Grade A or ASTM A 513, unless otherwise indicated or required to satisfy the performance requirements.
- D. Plates, Shapes, and Bars: ASTM A 36/A 36M.
 - 1. Welded Headed Studs: AWS D1.1 (Type A or B as selected by fabricator), ASTM A 108 Grades 1010 through 1020 inclusive and bearing the minimum mechanical properties for studs as selected by fabricator to suit performance requirements.
- E. Cold Finished Steel Bars: ASTM A 108, grade as selected by fabricator.

2.4 FASTENERS

- A. General: Provide the following:
 - 1. Galvanized Steel Railings: Plated fasteners complying with ASTM B 633, or ASTM F 1941, Class Fe/Zn 12 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 complying with the performance requirements.
- C. Post-Installed Anchors: Torque-controlled expansion or adhesive 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, conducted by a qualified independent testing agency.
 - 1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 12, unless otherwise indicated.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded [and as required at aluminum and stainless steel railings for color match, strength, and compatibility in fabricated items].
- B. Shop Primers: Provide primers that comply with Section 09 96 00 "High-Performance Coatings."
- C. Shop Primer for Galvanized Steel: Zinc-dust, zinc-oxide primer formulated for priming zinc-coated steel and for compatibility with finish paint systems indicated, and complying with SSPC-Paint 5.
- 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.
- F. 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.

2.6 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 comply with the performance requirements.
- 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. Shear, cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded 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. Weld connections 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 flux immediately.
 - 4. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.
- I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
- J. Form changes in direction as indicated on the Drawings.
- 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. Fabricate joints that will be exposed to weather in a watertight manner.
- N. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns.
- O. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, 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.
- P. 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.
- Q. For railing posts set in concrete, provide steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.
- R. Provide minimum 3/8 inch diameter weep holes or another means to drain entrapped water in hollow sections of railing members that are exposed to exterior or to moisture from condensation or other sources.

2.7 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. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.8 STEEL AND IRON FINISHES

- A. Galvanized Railings: Hot-dip galvanize exterior steel and iron railings to comply with ASTM A 123. Hot-dip galvanize hardware for exterior steel and iron railings to comply with ASTM A 153/A 153M.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123, for galvanizing steel and iron products.
 2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
 3. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
- C. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- D. For galvanized railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- E. For nongalvanized steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.
- F. Primer Application: Apply shop primer to prepared surfaces of railings, except those with galvanized finishes and those to be field welded, unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
1. Stripe paint edges, corners, crevices, bolts, and welds.
 2. Dry Film Thickness of Primer: 2.5 to 3.0 mils, dry film thickness. Apply paint thoroughly and evenly to dry surfaces, free from holidays and pinholes, in accordance with manufacturers directions.
- G. Do not deliver primed railing work until primer has dried.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required to meet or exceed the performance requirements.
- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

- A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

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. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.
- C. 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. Anchor posts to steel by welding directly to steel supporting members.

3.5 ATTACHING RAILINGS

- A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.

- C. Attach railings to wall with wall brackets, except where end flanges are used. Provide brackets with 1-1/2 inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to meet or exceed the performance requirements.
 - 1. Use type of bracket with predrilled hole for exposed bolt anchorage.
- D. Secure wall brackets and railing end flanges to building construction as required to meet or exceed the performance requirements and the following:
 - 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. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed reinforcements using self-tapping screws of size and type required to satisfy the performance requirements.

3.6 ADJUSTING AND CLEANING

- A. Clean aluminum and stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.
- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material.
- C. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 96 00 "High-Performance Coatings."
- D. 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.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 52 13

SECTION 05 73 00 - DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes ornamental metal handrails and railings.
- B. Related Requirements:
 - 1. Section 05 52 13 "Pipe and Tube Railings" for handrails and railings fabricated from pipe and tube components.
 - 2. Division 26 Sections for electrical wiring, connections, and installation of remote-control switches for light fixtures and electrical components.

1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Handrails and railings, grout, and paint products indicated.
 - 2. Grout.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Shop Drawings: Submit shop drawings of railing work. Include plans, elevations, and sections, showing working points and column centerline locations in plan and in section. Include details of metal railings and their connections to supporting framing, reinforcements, anchors, welded and bolted field and shop connections (size and location); other details showing relationships with, attachment to, and reception of, adjacent work. Shop drawings shall be signed and sealed by a professional Engineer licensed in the state where the work is to be installed.
 - 1. Include plans and elevations at not less than 1 inch to 1 footscale, and include details of sections and connections at not less than 3 inches to 1 footscale.
- D. Samples: Submit samples for each type of exposed finish required.
 - 1. Sections of each distinctly different linear railing member, including handrails, top rails, and posts.
 - 2. Welded connections.
 - 3. Assembled Samples of railing systems, made from full-size components, including top rail, and base. Samples need not be full height.

- E. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, submit copies of structural calculations indicating complete compliance with the specified performance requirements. Include structural analysis for support members, anchors, rails, and fittings. Provide reaction loads to adjacent structure. Calculations shall be prepared, signed and sealed by a Professional Engineer registered in the state wherein the work is to be erected and who is experienced in providing engineering services of the kind indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.
- C. Mill Certificates: Submit mill certificates signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.

1.4 QUALITY ASSURANCE

- A. Standards: Except as modified by governing codes and the Contract Documents, comply with the applicable provisions and recommendations of the following:
 - 1. NAAMM "Metal Finishes Manual."
 - 2. National Ornamental & Miscellaneous Metals Association (NOMMA) Metal Rail Manual.
- B. Fabricator/Installer Qualifications: A firm experienced in producing custom type handrails and railings similar to those indicated for this Project for a minimum of 5 years, with a record of successful in-service performance, with sufficient production capacity to produce required units without causing delay in the work.
 - 1. Employ only experienced tradesmen for both fabrication and installation, who are capable of producing work of the highest standards of quality in the industry.
- C. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- D. Product Options: Drawings indicate size, profiles, and dimensional requirements of railings and are based on the specific system indicated. Refer to Section 01 60 00 "Product Requirements."
 - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

- E. 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, "Structural Welding Code - Stainless Steel."
- F. 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 mockups for each form and finish of railing consisting of two posts, top rail, infill area, and anchorage system components that are full height and are not less than 24 inches in length.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- G. Preinstallation Conference: Conduct conference at Project site.

1.5 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.6 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 suit structural performance requirements.

PART 2 - PRODUCTS

2.1 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. Aluminum: The lesser of minimum yield strength divided by 1.65, or minimum ultimate tensile strength divided by 1.95.
 2. Copper Alloys: 60 percent of minimum yield strength.
 3. Stainless Steel: 60 percent of minimum yield strength.
 4. 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 lb/ft.in accordance with ASCE 7, applied in any direction.
 - b. Concentrated load of 200 lbin accordance with ASCE 7, applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - d. Seismic loads per [CBC] [IBC] and ASCE 7.
 2. Infill of Guards:
 - a. Concentrated load of 50 lb applied horizontally on an area of 1 sq. ft.in accordance with ASCE 7.
 - b. Infill load and other loads need not be assumed to act concurrently.
 3. Deflection Criteria: The larger deflections at the top from either the horizontal live loads or applicable wind loads shall be the lesser of 3/4-inch or $h/90$ for cantilever elements, and $h/175$ for simple span elements, where h is the distance from the floor level to the top of guardrail. Applied loads shall be allowable stress design loads.
- D. Exterior Metal Fabrications: All exterior railings shall be fabricated and installed to prevent buckling, glass breakage, opening up of joints and overstressing of welds and fasteners under the following temperature conditions:
1. Base fabrication on a temperature of +70 degrees F. at time of installation with allowance made for an exposed metal surface temperature range of -5 to +180 deg F. Make all necessary adjustments and provisions for concealed expansion.
- E. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: For the fabrication of ornamental metal work which will be exposed to view, provide materials matching the Architect's sample in color and grain characteristics with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations including welds which do not match the material, or blemishes.
1. Surface Flatness and Edges: For exposed work provide materials which have been cold-rolled, cold-finished, cold-drawn, extruded, stretcher leveled, machine cut and otherwise produced to the highest commercial standard for flatness with edges and corners sharp and true to angle or curvature as required.
 2. Alloys and Tempers: Wherever alloys or tempers of metals are not shown or specified only by series or other general designation, provide the specific alloy which will weld and machine properly, and will finish to match the Architect's sample and other work in the same area, which is shown or specified to have the same finish. Use the temper or hardness which will provide the greatest strength and durability, consistent with necessary forming, fabrication and finishing processes.

2.3 METALS

- A. Carbon Steel and Iron:
1. Tubing: ASTM A 500/A 500M (cold formed), grade as required by structural loads.
 2. Bars, Hot Rolled: ASTM A 29/A 29M, Grade 1010.
 3. Bars, Cold Finished: ASTM A 108/A 108M.
 4. Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.4 MISCELLANEOUS MATERIALS

- A. Fasteners: Same basic metal as fastened metal; concealed, unless otherwise indicated or unavoidable, and standard with systems indicated.
- B. Anchors: Fabricated from corrosion-resistant materials with capability to sustain, 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 per ASTM E 488.
- C. Shop Primer for Galvanized Steel: High-zinc-dust-content paint for reglvanizing welds in steel, complying with SSPC-Paint 20.
- D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
 - 1. Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- F. Connections: Fabricate railings with welded connections unless otherwise indicated.
- G. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.
- H. Form changes in direction as follows:
 - 1. As detailed.
- I. Form simple and compound curves by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- J. Close exposed ends of hollow railing members with prefabricated end fittings.
- K. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is 1/4 inch or less.

- L. Provide weep holes or another means to drain entrapped water in hollow sections of railing members that are exposed to exterior or to moisture from condensation or other sources.

2.6 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. 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 CARBON STEEL FINISHES

- A. Galvanized Railings:
 - 1. Hot-dip galvanize exterior steel and iron railings, including hardware, after fabrication.
 - 2. Hot-dip galvanize indicated steel and iron railings, including hardware, after fabrication.
 - 3. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
 - 4. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
 - 5. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
 - 6. Fill vent and drain holes that are 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. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, but galvanize anchors to be embedded in exterior concrete or masonry.
- E. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

1. Exterior Railings: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 2. Railings Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 3. Railings Indicated to Receive Primers Specified in Section 09 96 00 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
- G. Shop-Painted Finish: Comply with Section 09 96 00 "High-Performance Coatings."
1. Color: Match Architect's sample.

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 to install handrails and railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet .
 3. Align rails so variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet .
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. 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. Use wood blocks and padding to prevent damage to railing members and fittings. 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 beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.4 ANCHORING POSTS

- A. Use steel pipe 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 deep and 3/4 inch 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 flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For aluminum railings, attach posts as indicated using fittings designed and engineered for this purpose.
 - 2. For copper-alloy railings, attach posts as indicated using fittings designed and engineered for this purpose.
 - 3. For stainless steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
 - 4. For steel railings, weld flanges to posts 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 to concrete and masonry with sleeves concealed within railing ends and anchored to wall construction with anchors and bolts.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.
- C. Attach handrails to walls with wall brackets except where end flanges are used. Provide brackets with 1-1/2-inch 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. For wood stud partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with carpentry work to locate backing members.
 - 4. For steel-framed partitions, use hanger or lag bolts set into fire-retardant-treated wood backing between studs. Coordinate with stud installation to locate backing members.
 - 5. For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural loads.
 - 6. For steel-framed partitions, fasten brackets with toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.6 FIELD QUALITY CONTROL

- A. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Test railings according to ASTM E 894 and ASTM E 935 for compliance with performance requirements.
- B. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to Architect and comply with specified requirements.
- C. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

3.7 CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed 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 dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 96 00 "High-Performance Coatings."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

3.8 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.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 73 00

SECTION 06 18 00 - GLUED-LAMINATED CONSTRUCTION

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 framing using structural glued-laminated timber.

1.3 DEFINITIONS

- A. Structural Glued-Laminated (Glulam) Timber: An engineered, stress-rated timber product assembled from selected and prepared wood laminations bonded together with adhesives and with the grain of the laminations approximately parallel longitudinally.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data on lumber, adhesives, fabrication, and protection.
 - 2. For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
 - 3. For connectors. Include installation instructions.
- B. Shop Drawings:
 - 1. Show layout of structural glued-laminated timber system and full dimensions of each member.
 - 2. Indicate species and laminating combination.
 - 3. Include large-scale details of connections.
- C. Samples: Full width and depth, 24 inches long, showing the range of variation to be expected in appearance of structural glued-laminated timber including variations due to specified treatment.
 - 1. Apply specified factory finish to three sides of half length of each Sample. Submit wood finish samples on the same wood that is to be used and include metal finish on the actual metal to be used.

1.5 INFORMATIONAL SUBMITTALS

- A. Certificates of Conformance: Issued by a qualified testing and inspecting agency indicating that structural glued-laminated timber complies with requirements in AITC A190.1.
- B. Material Certificates: For preservative-treated wood products, from manufacturer. Indicate type of preservative used and net amount of preservative retained.
- C. Research/Evaluation Reports: For structural glued-laminated timber and timber connectors, from ICC-ES.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: An AITC- or APA-EWS-licensed firm

1.7 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with provisions in AITC 111.
- B. Individually wrap members using plastic-coated paper covering with water-resistant seams.

PART 2 - PRODUCTS

2.1 STRUCTURAL GLUED-LAMINATED TIMBER

- A. General: Provide structural glued-laminated timber that complies with AITC A190.1 and AITC 117 or research/evaluation reports acceptable to authorities having jurisdiction.
 - 1. Factory mark each piece of structural glued-laminated timber with AITC Quality Mark or APA-EWS trademark. Place mark on surfaces that are not exposed in the completed Work.
 - 2. Provide structural glued-laminated timber made from single species.
 - 3. Provide structural glued-laminated timber made from solid lumber laminations; do not use laminated veneer lumber.
 - 4. Provide structural glued-laminated timber made with wet-use adhesive complying with AITC A190.1.
- B. Species and Grades for Structural Glued-Laminated Timber: Douglas fir-larch that complies with combination symbols indicated on drawings.
- C. Appearance Grade: Architectural, complying with AITC 110.

1. For Premium and Architectural appearance grades, fill voids as required by AITC 110. For Premium appearance grade, use clear wood inserts, of matching grain and color, for filling voids and knot holes more than 1/4 inch wide.

2.2 PRESERVATIVE TREATMENT

- A. Preservative Treatment: Where preservative-treated structural glued-laminated timber is indicated, comply with AWP A U1, Use Category 3B
 1. Use preservative solution without water repellents or substances that might interfere with application of indicated finishes.
- B. Preservative: One of the following:
 1. Oxine copper (copper-8-quinolinolate) in a light petroleum solvent.
 2. Pentachlorophenol in light petroleum solvent.
 3. Copper naphthenate in a light petroleum solvent.
 4. Ammoniacal zinc copper arsenate (ACZA) in a water solution.
 5. Chromated copper arsenate (CCA) in a water solution.
 6. Ammoniacal copper quat Type A (ACQ-C) in a water solution.
 7. Propiconazole tebuconazole imidacloprid (PTI) in a water emulsion.
 8. KlearGard25
- C. Coordinate preservative treatment with Glulam sample as noted in Section 1.4. The approved Stain and finish shall be coordinated with preservative treatment and approved sample.
- D. After dressing members, apply a copper naphthenate field-treatment preservative to comply with AWP A M4 to surfaces cut to a depth of more than **1/16 inch**.

2.3 TIMBER CONNECTORS

- A. Materials: Unless otherwise indicated, fabricate from the following materials:
 1. Structural-steel shapes, plates, and flat bars complying with ASTM A 36/A 36M.
 2. Round steel bars complying with ASTM A 575, Grade M 1020.
 3. Hot-rolled steel sheet complying with ASTM A 1011/A 1011M, Structural Steel, Type SS, Grade 33.
- B. Finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil dry film thickness.

2.4 MISCELLANEOUS MATERIALS

- A. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.
- B. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

2.5 FABRICATION

- A. Shop fabricate for connections to greatest extent possible, including cutting to length and drilling bolt holes.
 - 1. Dress exposed surfaces as needed to remove plane and surfacing marks.
- B. Camber: Fabricate horizontal and inclined members of less than 1:1 slope with either circular or parabolic camber equal to 1/500 of span.
- C. Where preservative-treated members are indicated, fabricate (cut, drill, surface, and sand) before treatment to greatest extent possible. Where fabrication must be done after treatment, apply a field-treatment preservative to comply with AWP A M4.
 - 1. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
 - 2. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.
- D. End-Cut Sealing: Immediately after end cutting each member to final length and after preservative treatment, apply a saturation coat of end sealer to ends and other cross-cut surfaces, keeping surfaces flood coated for not less than 10 minutes.
- E. Seal Coat: After fabricating, sanding, and end-coat sealing, apply a heavy saturation coat of approved stain and or penetrating sealer on surfaces of each unit except for preservative-treated wood where treatment included a water repellent.

2.6 FACTORY FINISHING

- A. Wiped Stain Finish: Manufacturer's standard, dry-appearance, penetrating acrylic stain and sealer; oven dried and resistant to mildew and fungus.
 - 1. Color: As noted on Architectural Drawings.

- B. Clear Finish: Manufacturer's standard, two-coat, clear varnish finish; resistant to mildew and fungus.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates in areas to receive structural glued-laminated timber, with Installer present, for compliance with requirements, 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: Erect structural glued-laminated timber true and plumb and with uniform, close-fitting joints. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.
 - 1. Handle and temporarily support glued-laminated timber to prevent surface damage, compression, and other effects that might interfere with indicated finish.
- B. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with requirements for shop fabrication.
- C. Fit structural glued-laminated timber by cutting and restoring exposed surfaces to match specified surfacing and finishing.
 - 1. Predrill for fasteners using timber connectors as templates.
 - 2. Finish exposed surfaces to remove plane or surfacing marks and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
 - 3. Coat cross cuts with end sealer.
 - 4. Where preservative-treated members must be cut during erection, apply a field-treatment preservative to comply with AWP A M4.
 - a. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
 - b. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.
- D. Install timber connectors as indicated.

1. Unless otherwise indicated, install bolts with same orientation within each connection and in similar connections.
2. Install bolts with orientation as indicated or, if not indicated, as directed by Architect.

3.3 ADJUSTING

- A. Repair damaged surfaces and finishes after completing erection. Replace damaged structural glued-laminated timber if repairs are not approved by Architect.

3.4 PROTECTION

- A. Do not remove wrappings on individually wrapped members until they no longer serve a useful purpose, including protection from weather, sunlight, soiling, and damage from work of other trades.
 1. Coordinate wrapping removal with finishing work. Retain wrapping where it can serve as a painting shield.
 2. Slit underside of wrapping to prevent accumulation of moisture inside the wrapping.

END OF SECTION 06 18 00

SECTION 06 18 00 - GLUED-LAMINATED CONSTRUCTION

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 framing using structural glued-laminated timber.

1.3 DEFINITIONS

- A. Structural Glued-Laminated (Glulam) Timber: An engineered, stress-rated timber product assembled from selected and prepared wood laminations bonded together with adhesives and with the grain of the laminations approximately parallel longitudinally.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data on lumber, adhesives, fabrication, and protection.
 - 2. For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
 - 3. For connectors. Include installation instructions.
- B. Shop Drawings:
 - 1. Show layout of structural glued-laminated timber system and full dimensions of each member.
 - 2. Indicate species and laminating combination.
 - 3. Include large-scale details of connections.
- C. Samples: Full width and depth, 24 inches long, showing the range of variation to be expected in appearance of structural glued-laminated timber including variations due to specified treatment.
 - 1. Apply specified factory finish to three sides of half length of each Sample. Submit wood finish samples on the same wood that is to be used and include metal finish on the actual metal to be used.

1.5 INFORMATIONAL SUBMITTALS

- A. Certificates of Conformance: Issued by a qualified testing and inspecting agency indicating that structural glued-laminated timber complies with requirements in AITC A190.1.
- B. Material Certificates: For preservative-treated wood products, from manufacturer. Indicate type of preservative used and net amount of preservative retained.
- C. Research/Evaluation Reports: For structural glued-laminated timber and timber connectors, from ICC-ES.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: An AITC- or APA-EWS-licensed firm

1.7 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with provisions in AITC 111.
- B. Individually wrap members using plastic-coated paper covering with water-resistant seams.

PART 2 - PRODUCTS

2.1 STRUCTURAL GLUED-LAMINATED TIMBER

- A. General: Provide structural glued-laminated timber that complies with AITC A190.1 and AITC 117 or research/evaluation reports acceptable to authorities having jurisdiction.
 - 1. Factory mark each piece of structural glued-laminated timber with AITC Quality Mark or APA-EWS trademark. Place mark on surfaces that are not exposed in the completed Work.
 - 2. Provide structural glued-laminated timber made from single species.
 - 3. Provide structural glued-laminated timber made from solid lumber laminations; do not use laminated veneer lumber.
 - 4. Provide structural glued-laminated timber made with wet-use adhesive complying with AITC A190.1.
- B. Species and Grades for Structural Glued-Laminated Timber: Douglas fir-larch that complies with combination symbols indicated on drawings.
- C. Appearance Grade: Architectural, complying with AITC 110.

1. For Premium and Architectural appearance grades, fill voids as required by AITC 110. For Premium appearance grade, use clear wood inserts, of matching grain and color, for filling voids and knot holes more than 1/4 inch wide.

2.2 PRESERVATIVE TREATMENT

- A. Preservative Treatment: Where preservative-treated structural glued-laminated timber is indicated, comply with AWP A U1, Use Category 3B
 1. Use preservative solution without water repellents or substances that might interfere with application of indicated finishes.
- B. Preservative: One of the following:
 1. Oxine copper (copper-8-quinolinolate) in a light petroleum solvent.
 2. Pentachlorophenol in light petroleum solvent.
 3. Copper naphthenate in a light petroleum solvent.
 4. Ammoniacal zinc copper arsenate (ACZA) in a water solution.
 5. Chromated copper arsenate (CCA) in a water solution.
 6. Ammoniacal copper quat Type A (ACQ-C) in a water solution.
 7. Propiconazole tebuconazole imidacloprid (PTI) in a water emulsion.
 8. KlearGard25
- C. Coordinate preservative treatment with Glulam sample as noted in Section 1.4. The approved Stain and finish shall be coordinated with preservative treatment and approved sample.
- D. After dressing members, apply a copper naphthenate field-treatment preservative to comply with AWP A M4 to surfaces cut to a depth of more than **1/16 inch**.

2.3 TIMBER CONNECTORS

- A. Materials: Unless otherwise indicated, fabricate from the following materials:
 1. Structural-steel shapes, plates, and flat bars complying with ASTM A 36/A 36M.
 2. Round steel bars complying with ASTM A 575, Grade M 1020.
 3. Hot-rolled steel sheet complying with ASTM A 1011/A 1011M, Structural Steel, Type SS, Grade 33.
- B. Finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil dry film thickness.

2.4 MISCELLANEOUS MATERIALS

- A. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.
- B. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

2.5 FABRICATION

- A. Shop fabricate for connections to greatest extent possible, including cutting to length and drilling bolt holes.
 - 1. Dress exposed surfaces as needed to remove plane and surfacing marks.
- B. Camber: Fabricate horizontal and inclined members of less than 1:1 slope with either circular or parabolic camber equal to 1/500 of span.
- C. Where preservative-treated members are indicated, fabricate (cut, drill, surface, and sand) before treatment to greatest extent possible. Where fabrication must be done after treatment, apply a field-treatment preservative to comply with AWP A M4.
 - 1. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
 - 2. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.
- D. End-Cut Sealing: Immediately after end cutting each member to final length and after preservative treatment, apply a saturation coat of end sealer to ends and other cross-cut surfaces, keeping surfaces flood coated for not less than 10 minutes.
- E. Seal Coat: After fabricating, sanding, and end-coat sealing, apply a heavy saturation coat of approved stain and or penetrating sealer on surfaces of each unit except for preservative-treated wood where treatment included a water repellent.

2.6 FACTORY FINISHING

- A. Wiped Stain Finish: Manufacturer's standard, dry-appearance, penetrating acrylic stain and sealer; oven dried and resistant to mildew and fungus.
 - 1. Color: As noted on Architectural Drawings.

- B. Clear Finish: Manufacturer's standard, two-coat, clear varnish finish; resistant to mildew and fungus.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates in areas to receive structural glued-laminated timber, with Installer present, for compliance with requirements, 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: Erect structural glued-laminated timber true and plumb and with uniform, close-fitting joints. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.
 - 1. Handle and temporarily support glued-laminated timber to prevent surface damage, compression, and other effects that might interfere with indicated finish.
- B. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with requirements for shop fabrication.
- C. Fit structural glued-laminated timber by cutting and restoring exposed surfaces to match specified surfacing and finishing.
 - 1. Predrill for fasteners using timber connectors as templates.
 - 2. Finish exposed surfaces to remove plane or surfacing marks and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
 - 3. Coat cross cuts with end sealer.
 - 4. Where preservative-treated members must be cut during erection, apply a field-treatment preservative to comply with AWP A M4.
 - a. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
 - b. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.
- D. Install timber connectors as indicated.

1. Unless otherwise indicated, install bolts with same orientation within each connection and in similar connections.
2. Install bolts with orientation as indicated or, if not indicated, as directed by Architect.

3.3 ADJUSTING

- A. Repair damaged surfaces and finishes after completing erection. Replace damaged structural glued-laminated timber if repairs are not approved by Architect.

3.4 PROTECTION

- A. Do not remove wrappings on individually wrapped members until they no longer serve a useful purpose, including protection from weather, sunlight, soiling, and damage from work of other trades.
 1. Coordinate wrapping removal with finishing work. Retain wrapping where it can serve as a painting shield.
 2. Slit underside of wrapping to prevent accumulation of moisture inside the wrapping.

END OF SECTION 06 18 00

SECTION 061063 - EXTERIOR ROUGH CARPENTRY

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. Bench Type 1
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts and other items cast into concrete.
 - 2. Section 055000 "Metal Fabrication" for bench supports.

1.3 DEFINITIONS

- A. Boards: Lumber of less than 1 inch nominal in thickness and 4 inches nominal or greater in width used for framing.
- B. Dimension Lumber: Lumber of 6 inches nominal or greater but less than 2 inches in least dimension.
- C. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NLGA: National Lumber Grades Authority.
 - 2. WCLIB: West Coast Lumber Inspection Bureau.
 - 3. WWPA: Western Wood Products Association.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
 - 2. Lumber

- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
 - 1. Steel framing, supports, connections for wood bench.
- C. Samples for Verification: For each type and finish of metal.

1.5 INFORMATIONAL SUBMITTALS

- A. Certificates of Inspection: Issued by lumber grading agency for exposed wood products not marked with grade stamp.
- B. Evaluation Reports: For preservative-treated wood products, from ICC-ES.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

- A. Comply with DOC PS 20 and with grading rules of lumber grading agencies certified by ALSC's Board of Review as applicable. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by ALSC's Board of Review.
 - 1. Factory mark each item with grade stamp of grading agency.
 - 2. For items that are exposed to view in the completed Work, omit grade stamp and provide certificates of grade compliance issued by grading agency.
 - 3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
 - 4. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content:
 - 1. Boards: 15 percent.
 - 2. Dimension Lumber: 15 percent.

2.2 LUMBER

- A. Dimension Lumber: No. 1 Construction grade and the following species for the bench finish material:
 - 1. Thermally Modified Ash; NLGA.
 - a. 1x4 nominal decking, unfinished, supplied by Delta Millworks or equal.
- B. Boards: Any of the following species and grades for the bench undercarriage not visible:
 - 1. Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
 - 2. Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.

2.3 FASTENERS

- A. General: Provide fasteners of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.
 - 1. Use stainless steel unless otherwise indicated.
 - 2. For pressure-preservative-treated wood, use stainless steel fasteners.
- B. Power-Driven Fasteners: ICC-ES AC70.
- C. Wood Screws and Lag Screws: ASME B18.2.1, ASME B18.6.1, or ICC-ES AC233.
- D. Stainless Steel Bolts: ASTM F593, Alloy Group 1 or 2; with ASTM F594, Alloy Group 1 or 2 hex nuts and, where indicated, flat washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit work to other construction; scribe and cope as needed for accurate fit.
- B. Framing Standard: Comply with AF&PA WCD1 unless otherwise indicated.
- C. Install metal framing anchors to comply with manufacturer's written instructions.
- D. Do not splice structural members between supports unless otherwise indicated.
- E. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

- F. 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 members or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- G. Securely attach exterior rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. ICC-ES AC70 for power-driven fasteners.
 - 2. "Fastening Schedule" in ICC's International Building Code.

END OF SECTION 061063

SECTION 06 10 53 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes miscellaneous carpentry.

1.2 ACTION SUBMITTALS

- A. Product Data: Submit product data for each type of process and factory-fabricated product indicated.
 - 1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that materials comply with requirements.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."

1.3 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.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber, plywood, and other panels; for lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Regional Materials: Dimension lumber[, except treated materials,] shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

- B. Regional Materials: Dimension lumber[, except treated materials,] shall be manufactured within 500 miles of Project site.
- C. Regional Materials: Dimension lumber, except treated materials, shall be manufactured within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.
- D. Certified Wood: Lumber and plywood shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-00 and FSC STD-40-004.
- E. Lumber: Comply with DOC PS 20 "American Softwood Lumber Standard" and applicable rules of lumber grading agencies certified by the American Lumber Standards Committee Board of Review.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 - 3. Provide dressed lumber, S4S, unless otherwise indicated.
 - 4. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch nominal thickness or less, unless otherwise indicated.
- F. Wood Panels:
 - 1. Plywood: Comply with DOC PS 1 "Construction and Industrial Plywood" for plywood panels. Use exterior grade for panels in wet conditions.
 - 2. Thickness: As needed to comply with requirements specified but not less than thickness indicated.

2.2 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Provide chemical fire retardant process tested and labeled by UL with flame spread and smoke developed ratings of 25 or less. Comply with performance requirements in AWPA U1, Use Category UCFA as a minimum for pressure treatment. Size wood before treatment so that minimum cutting will be required after treatment. Kiln dry lumber to a maximum 19 percent moisture content, kiln dry plywood to a maximum 15 percent moisture content, after treatment. Treat indicated items and the following:
 - 1. Wood members required to be treated by Building Code having jurisdiction at the site and wood members specified as fire-retardant-treated.
- B. Identify fire-retardant-treated wood with appropriate classification marking of UL.

2.3 MISCELLANEOUS LUMBER

- A. Provide miscellaneous lumber for support or attachment of other construction, including blocking, nailers, and similar members.
- B. For concealed boards, provide lumber with 19 percent maximum moisture content and the following species and grades:
 - 1. Mixed southern pine, No. 2 grade; SPIB.
 - 2. Western Woods; WCLIB or WWPB, No. 2 Grade.

2.4 PANEL PRODUCTS

- A. Telephone, Data, Security, and Electrical Equipment Backing Panels:
 - 1. APA, Exposure 1, C-C Plugged, fire-retardant treated, manufactured with no added urea-formaldehyde, in thickness indicated or, if not indicated, not less than 3/4 inch thick.

2.5 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
- B. Power-Driven Fasteners: NES NER-272.
- C. Nails, Wire, Brads, and Staples: Select material, type, size, and finish required for each use.
 - 1. ASTM F 1667 for driven fasteners such as nails, spikes and staples.
 - 2. ASTM F 547 for nails used with wood and wood based products.
- D. Wood Screws: Select material, type, size, and finish required for each use. Comply with ASME B18.6.1.
- E. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Securely attach carpentry work as indicated and according to applicable codes and recognized standards.
- C. Use fasteners of appropriate type and length. Predrill members when necessary to avoid splitting wood.

3.2 WOOD BLOCKING AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3.3 PANEL PRODUCT INSTALLATION

- A. General: Comply with applicable recommendations contained in APA Form No. E30K, "APA Design/Construction Guide: Residential & Commercial," and local utility requirements, if any, for plywood backing panels utilized as indicated.
- B. Fastening Methods: Fasten panels as indicated below:
 1. Plywood Backing Panels: Secure to wall using proper fastening devices for substrates encountered spaced 12 inches on center maximum at perimeter 1/2 inch from corners and three rows of 3 fasteners each in the backerboard field. Countersink fasteners flush with plywood surface. Butt adjacent panels without lapping.

END OF SECTION 06 10 53

SECTION 06 16 00 - SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Roof sheathing.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.
- B. Sustainable Design Submittals:
1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.

1.3 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
1. Wood-preserved-treated plywood.
 2. Fire-retardant-treated plywood.

1.4 QUALITY ASSURANCE

- A. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: As tested according to ASTM E 119; 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.

2.2 PRESERVATIVE-TREATED PLYWOOD

1. Preservative Treatment by Pressure Process: AWP A 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].
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
- C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

2.3 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 E 84, 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 beyond the centerline of the burners at any time during the test.
 1. 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 D 2898. Use for exterior locations and where indicated.
 2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201/D 3201M at 92 percent relative humidity. Use where exterior type is not indicated.
- C. Kiln-dry material after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.
- E. Application: Treat all plywood unless otherwise indicated.

2.4 |WALL SHEATHING

- A. Glass-Mat Gypsum Sheathing: ASTM C 1177/1177M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Continental Building Products, LLC.
 - c. Georgia-Pacific Building Products.
 - d. National Gypsum Company.
 - e. Temple-Inland Building Products by Georgia-Pacific.
 - f. USG Corporation.
2. Type and Thickness: Type X, 5/8 inch thick.

2.5 ROOF SHEATHING

- A. Plywood Sheathing: DOC PS 1 , Exterior sheathing.

2.6 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 with hot-dip zinc coating complying with ASTM A 153/A 153M.

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. Coordinate wall 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.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

3.2 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. Fastening Methods: Fasten panels as indicated below:
 - 1. Wall and Roof Sheathing:
 - a. Screw to cold-formed metal framing.
 - b. Space panels 1/8 inch apart at edges and ends.

3.3 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 gap where non-load-bearing construction abuts structural elements.
 - 4. Install panels with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. 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.

END OF SECTION 06 16 00

SECTION 06 20 13 - EXTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Lumber soffits.

1.2 DEFINITIONS

- A. MDO: Plywood with a medium-density overlay on the face.
- B. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.
- B. Samples: For each exposed product and for each color and texture specified.

1.4 WARRANTY

- A. Manufacturer's Warranty for Wood Siding Soffits: Manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Factory-Applied Finish: Five years from date of Substantial Completion.
 - 2. Warranty Period for Siding Soffits (Excluding Finish): 25 years from date of Substantial Completion.

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 inspection agency, indicating grade, species, moisture content at time of surfacing, and mill.
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 inspection agency.

B. Softwood Plywood: DOC PS 1.

C. Hardboard: ANSI A135.4.

2.2 LUMBER SOFFITS

- A. Provide kiln-dried lumber siding complying with DOC PS 20, factory coated with exterior primer compatible with topcoats specified.
- B. Species and Grade: Douglas-fir; NLGA, WCLIB, or WWPA CV - Clear VERTICAL Grain .
- C. Pattern: Straight edge, smooth-faced tongue and groove, actual face width (coverage) and thickness of 4 by 9/16 inch .

2.3 MISCELLANEOUS MATERIALS

- A. Fasteners for Exterior Finish Carpentry: Provide nails or screws, in sufficient length to penetrate not less than 1-1/2 inches into wood substrate.
 1. For pressure-preservative-treated wood, provide hot-dip galvanized-steel fasteners.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.
- B. Prime lumber and moldings to be painted, including both faces and edges, unless factory primed.
 1. Cut to required lengths and prime ends.
 2. Comply with requirements in Section 09 91 13 "Exterior Painting."

3.2 INSTALLATION, GENERAL

- A. Install exterior finish carpentry level, plumb, true, and aligned with adjacent materials.

1. Use concealed shims where necessary for alignment.
2. Scribe and cut exterior finish carpentry to fit adjoining work.
3. Refinish and seal cuts as recommended by manufacturer.
4. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining exterior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
5. Coordinate exterior finish carpentry with materials and systems in or adjacent to it.
6. Provide cutouts for mechanical and electrical items that penetrate exterior finish carpentry.

3.3 INSTALLATION OF SIDING

- A. Install siding to comply with manufacturer's written instructions and warranty requirements.
- B. Horizontal Lumber Siding:
 1. Apply starter strip along bottom edge of sheathing or sill.
 2. Install first course of siding, with lower edge at least 1/8 inch below starter strip and subsequent courses lapped 1 inch over course below.
 - a. Nail at each stud.
 - b. Do not allow nails to penetrate more than one thickness of siding.
 3. Leave 1/8-inch gap at trim and corners unless otherwise recommended by manufacturer, and apply sealant.
 4. Butt joints only over framing or blocking, nailing top and bottom on each side and staggering joints in subsequent courses.

END OF SECTION 06 20 13

SECTION 07 13 26 - SELF-ADHERING SHEET 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. Blindsight sheet waterproofing.
 - 2. Molded-sheet drainage panels.
 - 3. Insulation drainage panels.
- B. Related Requirements:
 - 1. Section 07 95 13.16 "Exterior Expansion Joint Cover Assemblies" for exterior-wall expansion-joint assemblies that interface with waterproofing.
 - 2. Section 07 21 00 "Thermal Insulation"
 - 3. Section 07 14 13 "Hot Fluid-Applied Rubberized Asphalt Waterproofing" for interfaces at deck waterproofing.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

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: Show locations and extent of waterproofing and details of substrate joints and cracks, expansion joints, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
 - 1. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

1.5 INFORMATIONAL SUBMITTALS

- A. Research Reports: For modified bituminous sheet waterproofing/termite barrier, showing compliance with ICC AC380.
- 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.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
 - 1. Do not apply waterproofing in snow, rain, fog, or mist.
- B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.8 WARRANTY

- A. Manufacturer's Warranty:
 - 1. Waterproofing Warranty: Manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.
 - a. Warranty Period: Five years from date of Substantial Completion.

2. Termite Barrier Warranty: Manufacturer agrees to furnish replacement waterproofing termite barrier material and accessories for waterproofing termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.
 - a. Warranty Period: Ten years from date of Substantial Completion.
- B. Installer's Special Warranty: Specified form, signed by Installer, covering Work of this Section, for warranty period of two years.
 1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pavers on plaza decks.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Waterproofing System: Obtain waterproofing materials, protection course, molded-sheet drainage panels from single source from single manufacturer.

2.2 BLINDSIDE SHEET WATERPROOFING

- A. Blindside Sheet Waterproofing for Vertical Applications: Uniform, flexible, multilayered-composite sheet membrane that forms a permanent bond with fresh concrete placed against it; complete with accessories and preformed shapes for an unbroken waterproofing assembly; with the following physical properties:
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. GCP Applied Technologies Inc., PrePrufe SCS
 2. Physical Properties:
 - a. Low-Temperature Flexibility: Pass at minus 20 deg F; ASTM D1970/D1970M.
 - b. Peel Adhesion to Concrete: 5 lbf/in. minimum; ASTM D903, modified.
 - c. Lap Adhesion: 5 lbf/in. minimum; ASTM D1876, modified.
 - d. Hydrostatic-Head Resistance: 230 feet; ASTM D5385, modified.
 - e. Puncture Resistance: 100 lbf minimum; ASTM E154/E154M.
 - f. Water Vapor Permeance: 0.1 perm maximum; ASTM E96/E96M, Water Method.
 - g. Ultimate Elongation: 335 percent minimum; ASTM D412, modified.

- B. Blindside Sheet Waterproofing for Horizontal Applications: Uniform, flexible, multilayered-composite sheet membrane that forms a permanent bond with fresh concrete placed against it; complete with accessories and preformed shapes for an unbroken waterproofing assembly; with the following physical properties:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. GCP Applied Technologies Inc., PrePrufe 300R Plus
 2. Physical Properties:
 - a. Low-Temperature Flexibility: Pass at minus 20 deg F; ASTM D1970/D1970M.
 - b. Peel Adhesion to Concrete: 5 lbf/in. minimum; ASTM D903, modified.
 - c. Lap Adhesion: 5 lbf/in. minimum; ASTM D1876, modified.
 - d. Hydrostatic-Head Resistance: 230 feet; ASTM D5385, modified.
 - e. Puncture Resistance: 200 lbf minimum; ASTM E154/E154M.
 - f. Water Vapor Permeance: 0.1 perm maximum; ASTM E96/E96M, Water Method.
 - g. Ultimate Elongation: 335 percent minimum; ASTM D412, modified.
- C. Mastic, Adhesives, and Detail Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.

2.3 AUXILIARY MATERIALS

- A. Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
- B. Primer: Liquid waterborne primer recommended for substrate by sheet waterproofing material manufacturer.
- C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by sheet waterproofing material manufacturer.
- D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.
- E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.
- F. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8 inch, predrilled at 9-inch centers.

2.4 MOLDED-SHEET DRAINAGE PANELS

- A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of 9 to 21 gpm per ft. Insert values.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. GCP Applied Technologies Inc.
- B. Molded-Sheet Collector-Panel System with Polymeric Film: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven-geotextile facing with an apparent opening size not exceeding No. 40 sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of 9 to 17 gpm per ft. Insert values and a minimum horizontal, in-plane flow rate as indicated on Drawings Insert requirement. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. GCP Applied Technologies Inc.

2.5 INSULATION DRAINAGE PANELS

- A. Insulation: Comply with Section 07 21 00 "Thermal Insulation" for general building insulation.

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 waterproofing.
 - 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.
 3. Verify that compacted subgrade is dry, smooth, sound, and ready to receive waterproofing sheet.
- 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. 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.
- E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D4258.
 1. Install sheet strips of width according to manufacturer's written instructions and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch.
- F. Bridge and cover isolation joints, expansion joints, and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips of widths according to manufacturer's written instructions.
 1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
- G. Corners: Prepare, prime, and treat inside and outside corners in accordance with manufacturer's instructions.
 1. Install membrane strips centered over vertical inside corners. Install 3/4-inch fillets of liquid membrane on horizontal inside corners and as follows:
 - a. At footing-to-wall intersections, extend liquid membrane in each direction from corner or install membrane strip centered over corner.
 - b. At plaza-deck-to-wall intersections, extend liquid membrane or sheet strips onto deck waterproofing and to finished height of sheet flashing.

- H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions.

3.3 INSTALLATION OF BLINDSIDE SHEET WATERPROOFING

- A. Install blindside sheet waterproofing according to manufacturer's written instructions.
- B. Place and secure molded-sheet drainage panels over substrate. Lap edges and ends of geotextile to maintain continuity.
- C. Vertical Applications: Install sheet with face against substrate. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required by membrane manufacturer. Overlap and seal seams, and stagger and tape end laps to ensure watertight installation. Mechanically fasten to substrate.
 - 1. Securely fasten top termination of membrane with continuous metal termination bar anchored into substrate and cover with detail tape.
- D. Horizontal Applications: Install sheet with face against substrate. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required by membrane manufacturer. Overlap and seal seams, and stagger and tape end laps to ensure watertight installation.
- E. Corners: Seal lapped terminations and cut edges of sheet waterproofing at inside and outside corners with detail tape.
- F. Seal penetrations through sheet waterproofing to provide watertight seal with detail tape patches or wraps and a liquid-membrane troweling.
- G. Install sheet waterproofing and auxiliary materials to produce a continuous watertight tie into adjacent waterproofing.
- H. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Tape perimeter of damaged or nonconforming area extending 6 inches beyond repaired areas in all directions. Apply a patch of sheet waterproofing and firmly secure with detail tape.

3.4 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

- A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
 - 1. For vertical applications, install [**board insulation**] [**protection course**] before installing drainage panels.

3.5 INSTALLATION OF INSULATION DRAINAGE PANELS

- A. Install insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch of projections and penetrations.
- B. Ensure that drainage channels are aligned and free of obstructions.
- C. On vertical surfaces, set insulation drainage panels in adhesive or tape applied according to manufacturer's written instructions.
- D. On horizontal surfaces, loosely lay insulation drainage panels according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests, and to furnish reports to Architect.
- B. Manufacturer's Field Service: Engage a full-time site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components; and to furnish daily reports to Architect.
- C. Waterproofing will be considered defective if it does not pass tests and inspections.

3.7 PROTECTION, REPAIR, AND CLEANING

- 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.
- E. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07 13 26

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BP3-Goldwalk, Promenade-
Permit and IFC

**Steamboat Base Village
Redevelopment**
Steamboat Springs, Colorado

SECTION 07 14 13 - HOT FLUID-APPLIED RUBBERIZED ASPHALT 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. Rubberized-asphalt waterproofing membrane, reinforced.
 - 2. Molded-sheet drainage panels.
 - 3. Insulation.
- B. Related Requirements:
 - 1. Section 07 92 00 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
 - 2. Section 32 14 00 "Unit Paving" for plaza-deck pavers set on setting beds.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review waterproofing requirements, including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
- B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.
- B. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- C. Protect stored materials from direct sunlight.

1.8 FIELD CONDITIONS

- A. Weather Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, or when temperature is below zero deg F.
 - 1. Do not apply waterproofing in snow, rain, fog, or mist.
- B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace waterproofing and sheet flashings that do not comply with requirements or that fail to remain watertight within specified warranty period.
 - 1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pedestal-mounted pavers on plaza decks.
 - 2. Warranty insulation retains 80 percent of original published thermal value.
 - 3. Warranty pavers do not dish or warp and do not crack, split, or disintegrate in freeze-thaw conditions.

4. Warranty Period: 10 years from date of Substantial Completion.
- B. Special Installer's Warranty: Specified form signed by Installer, covering Work of this Section, for warranty period of two years.
 1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pedestal-mounted pavers on plaza decks.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain waterproofing materials molded-sheet drainage panels insulation from single source from single manufacturer.

2.2 WATERPROOFING MEMBRANE

- A. Hot Fluid-Applied, Rubberized-Asphalt Waterproofing Membrane: Single component; 100 percent solids; hot fluid-applied, rubberized asphalt.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. American Hydrotech, Inc.

2.3 AUXILIARY MATERIALS

- A. General: Auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with waterproofing.
- B. Primer: ASTM D 41/D 41M, asphaltic primer.
- C. Elastomeric Sheet: 50-mil- minimum, uncured sheet neoprene with manufacturer's recommended contact adhesives as follows:
 1. Tensile Strength: 1400 psi minimum; ASTM D 412, Die C.
 2. Elongation: 300 percent minimum; ASTM D 412.
 3. Tear Resistance: 125 psi minimum; ASTM D 624, Die C.
 4. Brittleness: Does not break at minus 30 deg F; ASTM D 2137.
- D. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum termination bars; approximately 1 by 1/8 inch thick; with stainless-steel anchors.

- E. Sealants and Accessories: Manufacturer's recommended sealants and accessories.
- F. Reinforcing Fabric: Manufacturer's recommended, spun-bonded polyester fabric.
- G. Protection Course: Manufacturer's standard, 80- to 90-mil- thick, fiberglass-reinforced rubberized asphalt or modified bituminous sheet.

2.4 MOLDED-SHEET DRAINAGE PANELS

- A. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a woven-geotextile facing with an apparent opening size not exceeding No. 40 sieve, laminated to one side with a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a horizontal flow rate not less than 2.8 gpm/ft..

2.5 INSULATION

- A. Unfaced Plaza-Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VII, 60-psi minimum compressive resistance; unfaced; fabricated with shiplapped or channel edges and with one side having ribbed drainage channels.

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. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
 - 2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and prepare substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate 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, form-release agents, paints, curing compounds, 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 D 4259 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 D 4258.
- E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, and other voids.

3.3 JOINTS, CRACKS, AND TERMINATIONS

- A. Prepare and treat substrates to receive waterproofing membrane, including joints and cracks, deck drains, corners, and penetrations according to manufacturer's written instructions.
 - 1. Rout and fill joints and cracks in substrate. Before filling, remove dust and dirt according to ASTM D 4258.
 - 2. Adhere strip of elastomeric sheet to substrate in a layer of hot rubberized asphalt. Extend elastomeric sheet a minimum of 6 inches on each side of moving joints and cracks or joints and cracks exceeding 1/8 inch thick, and beyond deck drains and penetrations. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.
 - 3. Embed strip of reinforcing fabric into a layer of hot rubberized asphalt. Extend reinforcing fabric a minimum of 6 inches on each side of nonmoving joints and cracks not exceeding 1/8 inch thick, and beyond roof drains and penetrations.
 - a. Apply second layer of hot fluid-applied, rubberized asphalt over reinforcing fabric.
- B. At expansion joints and discontinuous deck-to-wall or deck-to-deck joints, bridge joints with elastomeric sheet extended a minimum of 6 inches on each side of joints and adhere to substrates in a layer of hot rubberized asphalt. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.

3.4 FLASHING INSTALLATION

- A. Install elastomeric sheets at terminations of waterproofing membrane according to manufacturer's written instructions.

- B. Prime substrate with asphalt primer.
- C. Install elastomeric sheet and adhere to deck and wall substrates in a layer of hot rubberized asphalt.
- D. Extend elastomeric sheet up walls or parapets a minimum of 8 inches above plaza-deck pavers and 6 inches onto deck to be waterproofed.
- E. Install termination bars and mechanically fasten to top of elastomeric flashing sheet at terminations and perimeter of waterproofing.

3.5 MEMBRANE APPLICATION

- A. Apply primer, at manufacturer's recommended rate, over prepared substrate and allow it to dry.
- B. Heat and apply rubberized asphalt according to manufacturer's written instructions.
 - 1. Heat rubberized asphalt in an oil- or air-jacketed melter with mechanical agitator specifically designed for heating rubberized asphalt.
- C. Start application with manufacturer's authorized representative present.
- D. Reinforced Membrane: Apply hot rubberized asphalt to substrates and adjoining surfaces indicated. Spread to a thickness of 90 mils; embed reinforcing fabric, overlapping sheets 2 inches; spread another 125-mil- thick layer to provide a uniform, reinforced, seamless membrane 215 mils thick.
- E. Apply waterproofing over prepared joints and up wall terminations and vertical surfaces to heights indicated or required by manufacturer.
- F. Cover waterproofing with protection course with overlapped joints before membrane is subject to backfilling construction or vehicular traffic.

3.6 MOLDED-SHEET DRAINAGE PANEL INSTALLATION

- A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate according to manufacturer's written instructions. Use methods that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
 - 1. For vertical applications, install before installing drainage panels.

3.7 INSULATION INSTALLATION

- A. Install one or more layers of board insulation to achieve required thickness and insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch of projections and penetrations.
- B. On vertical surfaces, set insulation units into rubberized asphalt according to manufacturer's written instructions.
- C. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.8 FIELD QUALITY CONTROL

- A. Engage a full-time site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions; surface preparation; and application of membrane, flashings, protection, and drainage components; furnish daily reports to Architect.
 - 1. Site representative shall measure membrane thickness with pin tester or other suitable device at least once for every 100 sq. ft. and include measurements in reports.
- B. Testing Agency: Owner will engage a qualified testing agency to inspect substrate conditions, surface preparation, waterproofing application, protection, and drainage components, and to furnish reports to Architect.
 - 1. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after completing and protecting waterproofing but before overlaying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water. Testing agency shall observe flood testing.
 - a. Flood to an average depth of 2-1/2 inches with a minimum depth of 1 inch and not exceeding a depth of 4 inches. Maintain 2 inches of clearance from top of sheet flashings.
 - b. Flood each area for 72 hours.
 - c. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.

3.9 CLEANING AND PROTECTION

- A. Protect waterproofing from damage and wear during remainder of construction period.

- B. 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.
- C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 14 13

SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board.
2. Molded polystyrene foam-plastic board.
3. Polyisocyanurate foam-plastic board.
4. Glass-fiber blanket.
5. Mineral-wool board.

B. Related Requirements:

1. Section 07 13 26 "Self-Adhering Sheet Waterproofing" Section 07 14 13 "Hot Fluid-Applied Rubberized Asphalt Waterproofing" for insulated drainage panels installed with plaza deck insulation.
2. Section 09 29 00 "Gypsum Board" for sound attenuation blanket used as acoustic insulation.

1.2 ACTION SUBMITTALS

- A. Product Data:** For each type of product.
- B. Sustainable Design Submittals:** Refer to Division 01 Section "Sustainable Design Requirements."
- C. Low-emitting product certification.**

1.3 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.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics:** As determined by testing protocol required to achieve UL Classified rating. Identify products with appropriate markings of Underwriters Laboratories.

- B. Formaldehyde-Free: Third Party Certified with UL Environmental Validation.
- C. Recycled Content: A minimum of [50 (or highest available) percent] post-consumer recycled glass content, UL-validated.
- D. Low-Emitting Materials: For all thermal and acoustical applications of glassinsulation products, provide materials complying with the testing and products requirements of UL Environmental Validation and UL GreenGuard Gold certification.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
 - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD (XPS)

- A. Manufacturers: Subject to compliance with requirements, product products by one of the following:
 - 1. DiversiFoam Products.
 - 2. Dow Chemical Company (The).
 - 3. Owens Corning.
- B. Extruded Polystyrene Board, Type VII: ASTM C 578, Type VII, 60-psi minimum compressive strength; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.
- C. Extruded Polystyrene Board, Type VII, Drainage Panels: ASTM C 578, Type VII, 60-psi minimum compressive strength; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84; fabricated with shiplap or channel edges and with one side having grooved drainage channels.

2.2 MOLDED POLYSTYRENE FOAM-PLASTIC BOARD (EPS)

- A. Manufacturers: Subject to compliance with requirements, product products by one of the following:
 - 1. ACH Foam Technologies LLC
 - 2. DiversiFoam Products.
 - 3. Insulfoam LLC, a Carlisle Co.
- B. Molded Polystyrene Board, Type XV: ASTM C 578, Type XV, 60-psi minimum compressive strength.

2.3 POLYISOCYANURATE FOAM-PLASTIC BOARD

- A. Polyisocyanurate Board, Foil Faced: ASTM C 1289, foil faced, Type I, Class 1 or 2.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dow Chemical Company (The); Thermax.
 - b. RMax; TSX-8500.
 - c. RMax; ECOMAXci.
 - 2. Must comply with Section 2603.5.1 through 2603.5.7 of the IBC for Types I - IV construction.
 - 3. Flame spread of 25 or less and smoke developed index of 450 or less in accordance with ASTM E 84 or UL 723.

2.4 GLASS-FIBER BLANKET

- A. Manufacturers: Subject to compliance with requirements, product products by one of the following:
 - 1. CertainTeed Corporation
 - 2. Johns Manville.
 - 3. Knauf Insulation; EcoBatt Insulation with Ecosse Technology.
 - 4. Owens Corning.
- B. Sustainability Requirements: Provide glass-fiber blanket insulation as follows:
 - 1. Free of Formaldehyde: Insulation manufactured with formaldehyde-free binder.
 - 2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.

- C. Recycled Content of Insulation: Postconsumer recycled content not less than 50 percent (or highest available).
- D. 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.
- E. Glass-Fiber Blanket, Foil Faced: ASTM C 665, Type III (reflective faced), Class B (faced surface with a flame-propagation resistance of 0.12 W/sq. cm); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

2.5 MINERAL-WOOL BOARD

- A. Manufacturers: Subject to compliance with requirements, product products by the following:
 - 1. Thermafiber, Inc.; an Owens Corning company.
- B. Recycled Content of Insulation: Postconsumer recycled content not less than 50 percent (or highest available).
- C. Mineral-Wool Board, Types IA and IB, IVA and IVB, Unfaced: ASTM C 612, Types IA and IB; with maximum flame-spread and smoke-developed indexes of 15 and zero, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics. Nominal density of 4 lb/cu. ft., thermal resistivity of 4 deg F x h x sq.ft./Btu x in. at 75 deg F.
 - 1. Rainbarrier 40.

2.6 INSULATION FASTENERS

- A. Manufacturers: Subject to compliance with requirements, product products by one of the following:
 - 1. AGM Industries, Inc.
 - 2. Gemco.
 - 3. Rodenhouse, Inc.
- B. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
 - 1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - 2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

- C. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
 - 1. Angle: Formed from 0.030-inch- thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.
 - 2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.
- D. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
 - 1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
 - a. Crawl spaces.
 - b. Ceiling plenums.
 - c. Attic spaces.
 - d. <Insert location>.
- E. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 2 inches between face of insulation and substrate to which anchor is attached.
- F. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.
- G. Insulated sheathing manufacturer's recommended polymer or other corrosion protective coated steel screw fasteners for anchoring sheathing to metal wall framing. Fastener length and size based on wall sheathing thickness.

2.7 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
 - 1. Glass-Fiber Insulation: ASTM C 764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.

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 36 inches 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 36 inches 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 o.c. both ways on inside face and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.
1. 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."

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 clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
- 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..
2. Glass Mineral Wool Blankets: Measured and cut to desired measurements so as to fill gap completely with contact on all sides of surrounding insulation and not compression to finished thickness of material.

3.7 INSTALLATION OF CONTINUOUS INSULATION

- A. Install insulation in accordance with manufacturer's recommendations. Fasten to exterior face of exterior metal stud wall framing or cmu wall using sheathing manufacturer's recommended type and length screw fasteners with washers. Abut panels tightly together and around openings and penetrations.

3.8 INSTALLATION OF CURTAIN-WALL INSULATION

- A. Install board insulation in curtain-wall construction according to curtain-wall manufacturer's written instructions.
 1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated on Drawings between insulation and glass.
 2. Install insulation to fit snugly without bowing.

3.9 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 26 16 - UNDER-SLAB-ON-GRADE VAPOR RETARDER

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes vapor retarder and installation accessories for installation under concrete slabs on grade.
- B. Related Requirements:
 - 1. Section 03 30 00 "Cast-in-Place Concrete."

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site two weeks before start of installation of reinforced vapor retarders.
 - 1. Review vapor-retarder installation, protection, and coordination with other work.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated including installation instructions.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."

1.4 INFORMATIONAL SUBMITTALS

- A. Material Certificate signed by manufacturer.
- B. Summary of test results per paragraph 9.3 of ASTM E 1745.
- C. Manufacturer's installation instructions for placement, seaming and penetration repair instructions.

1.5 QUALITY ASSURANCE

- A. Provide vapor retarder and accessories from a single source and single manufacturer. Provide accessories manufactured or approved by vapor retarder manufacturer for application indicated.

- B. All mandatory ASTM E 1745 testing must be performed on a single production roll per ASTM E 1745 Section 8.1.
- C. Coordination: Schedule work such that membrane will not be left exposed to weather for longer than that recommended by the manufacturer.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in labeled packages. Store and handle in strict compliance with manufacturer's instructions. Protect from damage from weather, excessive temperature and construction operations. Remove and dispose of damaged material in accordance with applicable regulations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Vapor retarder shall have all of the following qualities:
 - 1. Maintain permeance of less than 0.01 Perms as tested in accordance with mandatory conditioning tests per ASTM E 1745 Section 7.1 (7.1.1-7.1.5).
 - 2. Other Performance Criteria:
 - a. Strength: ASTM E 1745 Class A.
 - b. Thickness: 15 mils minimum.

2.2 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Carlisle Coatings & Waterproofing, Inc.; Blackline 400.
 - b. Fortifiber Building Systems Group; Moistop Ultra 15.
 - c. Grace Construction Products, W. R. Grace & Co.; Florprufe 120.
 - d. Reef Industries, Inc.; Griffolyn 15 mil Green.
 - e. Stego Industries, LLC; Stego Wrap 15 mil Class A.

2.3 ACCESSORIES

- A. Vapor Retarding Seam Tape:
 - 1. Water Vapor Transmission Rate: 0.3 perms or lower per ASTM E 96.
- B. Vapor Proofing Mastic:
 - 1. Water Vapor Transmission Rate: 0.3 perms or lower per ASTM E 96.
- C. Pipe Boots: Provide manufacturer's factory fabricated pipe boots, or construct pipe boots from vapor barrier material, pressure sensitive tape and/or mastic per manufacturer's instructions.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine areas to receive vapor retarders. Notify Architect if areas are not acceptable. Do not begin installation until unacceptable conditions have been corrected.
- B. Ensure that subsoil is smooth, level and compacted with no sharp edges.
 - 1. Level and compact base material.
- C. Ensure that there is no moisture entrapment by vapor retarder due to rainfall or ground water intrusion.

3.2 INSTALLATION

- A. Install vapor retarder in accordance ASTM E 1643 and manufacturer's written instructions.
 - 1. Install vapor retarders continuously at locations under slab. Ensure there are no discontinuities in vapor retarder at seams or penetrations.
 - 2. Unroll vapor retarder with the longest dimension parallel with the direction of the concrete placement and face laps away from the expected direction of the placement whenever possible.
 - 3. Extend vapor retarder over footings and grade beams to a distance acceptable to the structural engineer or stop at impediments such as dowels and waterstops.
 - 4. Seal vapor retarder to foundation wall, grade beam, or slab at an elevation consistent with the top of the slab or terminate at impediments such as waterstops or dowels.
 - 5. Overlap joints 6 inches and seal with manufacturer's tape.
 - 6. Apply tape to a clean and dry vapor barrier.

7. Seal all penetrations with manufactured or field-fabricated boots and with tape according to manufacturer's guidelines. Unsealed penetrations are not allowed.
 8. Immediately repair damaged areas by cutting patches of vapor retarder, overlapping damaged area 6 inches and taping all sides with tape.
- B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder according to manufacturer's written instructions.

3.3 PROTECTION

- A. Protect vapor retarders from damage during installation of reinforcing steel and utilities and during placement of concrete slab.

END OF SECTION 07 26 16

SECTION 07 27 26 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vapor-permeable, fluid-applied air barriers.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For air-barrier assemblies.
 - 1. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Product test reports.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Low-Emitting Materials: Products shall comply with the 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."

2.2 PERFORMANCE REQUIREMENTS

- A. Air-Barrier Performance: Air-barrier 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, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Air-Barrier Assembly Air Leakage: Maximum 0.00001 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested according to ASTM E 2357.

2.3 LOW-BUILD AIR BARRIERS, VAPOR PERMEABLE

- A. Low-Build, Vapor-Permeable Air Barrier: Synthetic polymer material with an installed dry film thickness, according to manufacturer's written instructions, of 15 mils over smooth, void-free substrates.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. DOW Chemical Company; DEFEN AID 200C.
 - 2. Physical and Performance Properties:
 - a. Air Permeance: Maximum 0.01 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E 2178.
 - b. Vapor Permeance: Minimum 10 perms; ASTM E 96/E 96M, Desiccant Method, Procedure A.
 - c. Ultimate Elongation: Minimum 650 percent; ASTM D 412, Die C.
 - d. Adhesion to Substrate: Minimum 30 lbf/sq. in. when tested according to ASTM D 4541.
 - e. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

- f. UV Resistance: Can be exposed to sunlight for 360 days according to manufacturer's written instructions.

2.4 ACCESSORY MATERIALS

- A. Requirement: 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 air-barrier 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.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate according to manufacturer's written instructions and details. 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 fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.
- D. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- E. 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.
- F. Bridge isolation joints, expansion joints and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement according to manufacturer's written instructions and details.

3.2 INSTALLATION

- A. Install materials according to air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water 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.
 - 2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.

3. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
 4. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
- B. Connect and seal exterior wall air-barrier material 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.
- C. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames, with not less than 1 inch of full contact.
- D. 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 beyond repaired areas in strip direction.
- E. Low-Build Air Barriers: Apply continuous unbroken air-barrier material to substrates according to the following thickness. Apply an increased thickness of air-barrier material in full contact around protrusions such as masonry ties.
1. Vapor-Permeable, Low-Build Air Barrier: Total dry film thickness as recommended in writing by manufacturer to comply with performance requirements, applied in one or more equal coats. Apply additional material as needed to achieve void- and pinhole-free surface, but do not exceed thickness on which required vapor permeability is based.
- F. Do not cover air barrier until it has been tested and inspected by testing agency.
- G. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests: As determined by testing agency from among the following tests:
1. Air-barrier dry film thickness.
 2. Adhesion Testing: Air-barrier assemblies will be tested for required adhesion to substrate according to ASTM D 4541 for each 600 sq. ft. of installed air barrier or part thereof.
- C. Air barriers will be considered defective if they do not pass tests and inspections.

1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
 2. Remove and replace deficient air-barrier components for retesting as specified above.
- D. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
- E. Prepare test and inspection reports.

3.4 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
- B. Remove masking materials after installation.

END OF SECTION 07 27 26

SECTION 07 41 13.16 - 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.

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 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.
- 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 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. 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.
- B. 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 square by full thickness, including attachments, underlayment, and accessories.
2. Build mockups for typical roof area only, including accessories.
 - a. Size: 12 feet long by 6 feet.
 - b. Each type of exposed seam and seam termination.
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. 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 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.
- 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: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than Insert value percent.
- B. Solar Reflectance Index (SRI): Three-year-aged SRI not less than 64 or initial SRI not less than 82 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- C. Energy Performance: Provide roof panels that are listed on the EPA/DOE's ENERGY STAR "Roof Product List" for steep-slope roof products.

- D. 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 0.75.
 - 2. Three-year, aged Solar Reflectance Index of not less than 64 when calculated according to ASTM E 1980.
- E. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
 - 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.
 - 4. .
- F. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 1680 or ASTM E 283 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft..
- G. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 or ASTM E 331 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft..
- H. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.
- I. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
 - 1. Uplift Rating: UL 90.
- J. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS

- A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
- B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels : Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.
 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. Advanced Architectural Products.
 - b. Advanced Building Products Inc.
 - c. AEP Span; A BlueScope Steel Company.
 - d. Architectural Building Components.
 - e. Architectural Metal Systems.
 - f. ATAS International, Inc.
 - g. Berridge Manufacturing Company.
 - h. CENTRIA Architectural Systems.
 - i. Dimensional Metals, Inc.
 - j. Englert, Inc.
 - k. Fabral.
 - l. Firestone Building Products.
 - m. Firestone Metal Products, LLC.
 - n. Flexospan Steel Buildings, Inc.
 - o. Garland Company, Inc. (The).
 - p. IMETCO.
 - q. MBCI; a division of NCI Group, Inc.
 - r. McElroy Metal, Inc.
 - s. Merchant & Evans Inc.
 - t. Metal Sales Manufacturing Corporation.
 2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - a. Nominal Thickness: 0.0299 inch .
 - b. Exterior Finish: Bonderized.
 - c. Color: Match Architect's samples.
 3. Clips: Two-piece floating to accommodate thermal movement.
 - a. Material: 0.064-inch- nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.

4. Joint Type: Double folded.
5. Panel Coverage: 18 inches.
6. Panel Height: 2.0 inches,.

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
1. Thermal Stability: Stable after testing at 240 deg F; ASTM D 1970.
 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.
 3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Carlisle Residential; a division of Carlisle Construction Materials; WIP 300HT.
 - b. Grace Construction Products; W.R. Grace & Co. -- Conn.; Grace Ice and Water Shield HT.
 - c. Owens Corning; WeatherLock Metal High Temperature Underlayment.
- B. SUBSTRATE BOARDS - Products: Subject to compliance with requirements, provide one of the following:
1. Georgia-Pacific Corporation; Dens Deck Prime.
 2. USG Corporation; Securock Glass Mat Roof Board.
 3. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening substrate board to roof deck.
 4. Minimize the use of exposed fasteners.
- C. ROOF INSULATION - General: Preformed roof insulation boards manufactured or approved by Standing Seam roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated. Provide a minimum R-value of 30.
1. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle SynTec Incorporated.
 - b. Firestone Building Products.zeJohns Manville.
- D. VAPOR RETARDER -

1. Laminated Sheet: Polyethylene laminate, two layers, reinforced with cord grid, with maximum permeance rating of 0.06 perm.
 2. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- E. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.4 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- 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. Manufacturers snow fences: Provide and install manufacturers non structural snow fences to vertical seams per manufacturers recommendations. Snow Fences to match standing seam metal roof color.
- E. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- F. 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 wide and 1/8 inch thick.

2. Joint Sealant: ASTM C 920; 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.

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. 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 Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
 - 1. Bonderized Finish.
 - 2. 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 - 1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
 - 2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
 - a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 UNDERLAYMENT INSTALLATION

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.
 - 1. Apply over the entire standing seam roof surface.
- B. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels if required by manufacturer.
- 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. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
 - 2. Aluminum Panels: Use 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. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
 - 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 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 with no joints allowed within 24 inches 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 deep, filled with mastic sealant (concealed within joints).

- H. 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 on slope and location lines as indicated and within 1/8-inch 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 13.16

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manufactured reglets.
 - 2. Formed roof drainage system.
 - 3. Formed low-slope roof flashing and trim.
 - 4. Formed wall flashing and trim.
 - 5. Formed overhead-piping safety pans.
- B. Single Subcontract Responsibility: Refer to roofing sections for the requirements of single subcontract responsibilities for sheet metal flashing and trim.

1.2 ACTION SUBMITTALS

- A. Product Data: Submit product data for each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Shop Drawings: Submit shop drawings showing layouts of sheet metal flashing and trim, including plans and elevations. Distinguish between shop- and field-assembled work. Include the following:
 - 1. Identify material, thickness, weight, and finish for each item and location in Project.
 - 2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
 - 3. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
 - 4. Details of expansion-joint covers, including showing direction of expansion and contraction.
- D. Samples: Submit 8 inches x 8 inches (200 x 200 mm) square samples of sheet metal flashing, in the specified finish.

1.3 QUALITY ASSURANCE

- A. **Installer Qualifications:** Subcontract the sheet metal flashing and trim work to a firm which is specialized in the fabrication and installation of sheet metal flashing and trim and who has successfully installed work similar in design and extent to that required for the project, in not less than three projects of similar scope to the satisfaction of the Architect, and whose work has resulted in construction with a record of successful in-service performance for a period of 5 years. .
- B. **Sheet Metal Flashing and Trim Reference Standards:** Comply with the industry standard sources below. Where sheet metal flashing and trim work details have not been specifically detailed on the drawings or specified the Contractor shall submit, for the Architect's approval, proposed sheet metal detailing. The primary source for proposed sheet metal detailing shall come from the industry standard sources below.
 - 1. SMACNA's Architectural Sheet Metal Manual.
 - 2. NRCA's Roofing and Waterproofing Manual.
 - 3. ANSI/SPRI ES-1 Wind Design Standard for Edge Systems Used with Low Slope Roof Systems except where the Performance Requirements are more stringent.
- C. **Sealant Compatibility and Adhesion Testing:** Use sealant manufacturer's standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
- D. **Design Modifications:** Submit design modifications necessary to meet the performance requirements and field coordination. Variations in details or materials which do not adversely affect the appearance, durability or strength of components shall be submitted to the Architect for review. Maintain the general design concept without altering size of members, profiles and alignment.

1.4 COORDINATION

- A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

1.5 WARRANTY

- A. **Furnish written warranty against water leakage** resulting from defects of materials or workmanship. Upon notification of such defects, within the warranty period, make the necessary repairs and replacements at the convenience of, and no cost to, the Owner. This warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the Contract Documents.

- 1. Warranty period shall be 5 years after the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Fabricate and install exterior wall and roofing sheet metal flashing and trim capable of resisting the wind forces greater than or equal to those shown on Structural Drawings for components and cladding.
- C. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from surface temperatures ranging from -10 degrees F. to +180 degrees F., without buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements.
 - 1. Dimensions shown on Drawings are based on an assumed design temperature of +70oF. Fabrication and installation procedures shall take into account the ambient temperature range at the time of the respective operations.
- D. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

2.2 SHEET METALS

- A. Aluminum Sheet: ASTM B 209, Alloy 3003, 3004, 3105, or 5005, Temper suitable for forming and structural performance required, but not less than H14, finished as follows:
 - 1. High-Performance Organic Finish: Three-coat, thermocured system containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2604.
 - a. Color: Match Architect's samples.
- B. Stainless-Steel Sheet: ASTM A 240/A 240M, soft annealed, Type 304, No. 2D finish, except where harder temper is required for forming or performance.
- C. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality, mill phosphatized for field painting.
- D. Prepainted, Metallic-Coated Steel Sheet: Steel sheet metallic coated by the hot-dip process and prepainted 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 coating designation; structural quality.
2. Exposed Finishes: Apply the following coil coating:
 - a. High-Performance Organic Finish: Three-coat thermocured system containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with physical properties and coating performance requirements of AAMA 2604, except as modified for below:
 - 1) Humidity and Salt Spray Resistance: 2000 hours.
 - 2) Color: Match Architect's samples.

2.3 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.
- B. Underlayment: Self-Adhering, High-Temperature Sheet: 0.76 mm thick, self adhering, self sealing, underlayment consisting of slip-resisting high density cross laminated polyethylene-film top surface laminated to layer of butyl rubber based adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
 1. Product Reference: Grace, W. R. & Co.; Ultra.
- C. Fasteners: Wood screws, same metal as flashing/sheet metal, annular threaded nails, self-tapping screws, and other suitable fasteners designed to withstand design loads.
- D. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer, use a noncorrosive rosin flux over tinned surfaces.
- E. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.
- F. Elastomeric Sealant: ASTM C 920 and Section 07 92 00 "Joint Sealants," elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- G. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.
- H. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound.
- I. Bituminous Coating: Cold-applied bituminous paint complying with ASTM D 1187, compounded for 15 mil dry film thickness per coat.

- J. Wood Nailer Strips: Provide wood nailer strips, fabricated to sizes indicated, from lumber complying with the requirements of Section 06 10 53 "Miscellaneous Rough Carpentry" and fire retardant treated by pressure process using chemical solution which is non-hygroscopic and non-corrosive to sheet metal used.

2.4 REGLETS

- A. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -soldered corners and junctions.

1. Manufacturers:

- a. Cheney Flashing Company, Inc.
- b. Fry Reglet Corporation.
- c. Heckmann Building Products Inc.
- d. Hickman, W. P. Company.
- e. Keystone Flashing Company, Inc.
- f. Sandell Manufacturing Company, Inc.

2. Material: Stainless steel, 0.0187 inch thick.

3. Reglet Types:

- a. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
- b. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
- c. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
- d. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

2.5 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with the referenced standards that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.
- B. Fabricate sheet metal flashing and trim in thickness needed to comply with performance requirements, but not less than that specified for each application and metal.

- C. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 - 1. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 - 2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
- D. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.
- E. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
- F. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.
- G. Fabricate cleats and attachment devices from same material as accessory being anchored. Cleats shall be 2 inches wide by nominal 3 inches long typically, minimum 0.0187 inch thick, punch for minimum 2 nail or screw holes. One end shall be locked into seams, or into folded edge of sheet metal sheets, the other end shall be secured with nails or screws and folded back over nail or screw heads.
- H. Fabricate Fascia and Coping corners from one piece, miter and break corners to form crisp corners. Solder all seams for a water tight assembly to the sizes and shapes indicated on drawings.

2.6 ROOF DRAINAGE SHEET METAL FABRICATIONS

- A. Downspouts: Fabricate rectangular downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.
 - 1. Manufactured Hanger Style: Square.
 - 2. Fabricate downspouts from the following material:
 - a. Galvanized Steel: 0.0217 inch thick.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Copings: Fabricate in minimum 96 inches long, but not exceeding 10 foot long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder watertight.

1. Joint Style: Butt, with 6-inch- wide concealed expansion joints.
2. Fabricate copings from the following material:
 - a. Galvanized Steel: 0.0396 inch thick.
- B. Roof to Sheet Metal Roof Edging Transition Expansion-Joint Cover: Fabricate from the following material:
 1. Galvanized Steel: 0.0336 inch thick.
- C. Base Flashing: Fabricate from the following material:
 1. Stainless Steel: 0.0187 inch thick.
- D. Counterflashing and Flashing Receivers: Fabricate from the following material:
 1. Stainless Steel: 0.0187 inch thick.

2.8 WALL SHEET METAL FABRICATIONS

- A. Openings Flashing in Frame Construction: Fabricate through wall head, sill, jamb, base course/foundation, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- high end dams. Fabricate from the following material:
 1. Stainless Steel: 0.0156 inch thick.

2.9 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Overhead-Piping Safety Pans: Fabricate from the following material:
 1. Galvanized Steel: 0.0396 inch thick.

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 work.
 1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Torch cutting of sheet metal flashing and trim is not permitted.
- B. Nailer and Underlayment Installation for Copings:
 - 1. Provide wood nailers shown to properly install the coping. Form to shapes indicated and cut as required for true line and level of attached work. Set to required levels and lines. Allow approximately 1/8" between nailer ends and offset joints a minimum of 12" in multiple layers. Locate nailers to comply with requirements for attaching other construction.
 - 2. Utilize mechanical fasteners that will have no detrimental effect on the components of the coping. Recess fasteners flush with surfaces. Fasten in accordance with FM 1-49 standards and the coping manufacturers recommendations.
 - 3. Underlayment Installation: Install a course of self adhering high temperature sheet underlayment directly over nailers in accordance with the underlayment manufacturers instructions to the extent indicated on the drawings. Lap ends of underlayment lengths a minimum of 4 inches.
- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.
 - 1. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of underlayment.
 - 2. Bed flanges in thick coat of asphalt roofing cement where required for waterproof performance.
- D. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
- E. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, and butyl sealant.
- F. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 1. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.

- G. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
- H. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
 - 1. Galvanized or Prepainted, Metallic-Coated Steel: Use stainless-steel fasteners.
 - 2. Aluminum: Use aluminum or stainless-steel fasteners.
 - 3. Copper: Use copper or stainless-steel fasteners.
 - 4. Stainless Steel: Use stainless-steel fasteners.
- I. Seal joints with butyl sealant as required for watertight construction.
 - 1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant.
- J. Soldered Joints: Edges of sheets to be soldered shall be in close contact at every point along the joint before soldering. Edges of all sheets of sheet metal to be soldered shall be tinned with solder on both sides for a minimum width of 1-1/2 inches. Where specified, all seams shall be thoroughly soldered to produce watertight joints. All soldering shall be done slowly with well heated metal - to heat sheet thoroughly and to sweat solder completely through full width of seam. Ample solder shall be used and seam shall show at least one full inch of evenly flowed solder. Wherever possible all soldering shall be done in flat position. Remove every trace of flux residue from metal promptly after tinning. Comply with manufacturer's recommended methods for cleaning and neutralization. Clean exposed surfaces of sheet metal flashing and trim of every substance which is visible or might cause corrosion of metal surfaces. Use soldering irons (3 lb. Minimum each). Do not use abrasives in preparing the sheet metal surfaces for soldering. All exposed parts of finished soldered joints shall be smooth and free of smeared solder.
 - 1. Do not solder prepainted, metallic-coated steel and aluminum sheet.

3.3 ROOF DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to the referenced standards and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.
- B. Downspouts: Join sections with 1-1/2 inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

- C. Parapet Scuppers: Install scuppers where indicated through parapet. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
- D. Conductor Heads: Anchor securely to wall with elevation of conductor head rim 1 inch below gutter discharge.

3.4 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal roof flashing and trim to comply with performance requirements and the referenced standards. Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to ANSI/SPRI ES-1 to comply with the performance requirements.
- C. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49.
 - 1. Interlock bottom edge of roof edge flashing with continuous cleats anchored to substrate at 16 inch centers.
- D. Copings: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49.
 - 1. Interlock exterior bottom edge of coping with continuous cleats anchored to substrate at 16 inch centers.
 - 2. Anchor interior leg of coping with screw fasteners and washers at 18 inch centers.
- E. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated. Lap joints a minimum of 4 inches in direction of water flow.
- F. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
- G. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Secure in a waterproof manner. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with butyl sealant.
- H. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:

1. Turn lead flashing down inside vent piping, being careful not to block vent piping with flashing.
2. Seal with butyl sealant and clamp flashing to pipes penetrating roof except for lead flashing on vent piping.

3.5 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Reglets: Installation of reglets is specified in Section 03 30 00 "Cast-in-Place Concrete." Section 04 20 00 "Unit Masonry."
- C. Through-Wall Flashing: Installation of formed through-wall flashing is specified in Section 04 42 00 "Exterior Stone Cladding."
- D. Openings Flashing in Frame Construction: Install continuous through wall head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

3.6 MISCELLANEOUS SHEET METAL FABRICATION INSTALLATION

- A. Overhead-Piping Safety Pans: Suspend pans from pipe and install drain line to plumbing waste or drain line.
- B. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Seal flashing with butyl sealant to equipment support member.

3.7 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces for uniform oxidation and weather exposure; neutralize flux materials; clean off excess solder and sealants; and remove strippable films, if any.
- B. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, and pieces of flashing. Maintain in a clean condition during construction.
- C. 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.

END OF SECTION 07 62 00

PART 1 - SECTION 07 70 00 - ROOF ICE MELT (RIM) SYSTEMS GENERAL

1.1 SUMMARY

- A. Section includes a high-performance roof and gutter de-icing system consisting of aluminium base extrusions, metallic cover panels, and UL Listed/CSA Certified self-regulating heating cable, connection kits and electronic controller.
- B. Related Requirements
 - 1. Section 07 41 13.16 - Standing-Seam Metal Roof Panels
 - 2. Section 07 54 23 - Thermoplastic Polyolefin (TPO) Roofing
 - 3. Section 07 62 00 - Sheet Metal Flashing and Trim
 - 4. Section 07 71 00 - Roof Specialties
 - 5. Section 07 71 23 - Manufactured Gutters and Downspouts (if applicable as Alternate)
 - 6. Section 26 00 00 - Electrical

1.2 REFERENCES

- A. Reference Standards
 - 1. UL515 - Electrical Resistance Heat Tracing for Commercial Applications
 - 2. IEEE 515.1-2012 Standard for the Testing, Design, Installation & Maintenance of Electric Resistance Trace Heating for Commercial Applications.
 - 3. NFPA 70 - National Electrical Code

1.3 SYSTEM DESCRIPTION

- A. System for roof and gutter de-icing with ambient, surface and moisture sensing control, monitoring, integrated ground-fault circuit protection and Building Management System (BMS) communication capabilities.
 - 1. RIM System for heavy snow load areas, and Raychem RIM2 system for light to moderate snow load areas.
 - 2. IceStop OR WFP self-regulating heating cable
 - 3. C910 snow/icing melting controller

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- A. Product Data
 - 1. Heating cable data sheet

2. RIM Panels data sheet
3. System installation and operation instructions.
4. System installation details
5. Connection kits and accessories data sheet
6. Controller wiring diagram
7. Installation Check-Out Forms to be completed after the installation is finished

B. Shop Drawings

1. Detail drawings showing layouts for each RIM Section, indicating power connections, splice, end terminations, and circuit cable length.

1.5 QUALITY ASSURANCE

- A. Source Limitations:** All system components [heating cable, metal panels, connection kits, and controller] shall be sourced from a single manufacturer, under no circumstances shall any components be installed other than those supplied by the cable manufacturer, to ensure system integrity and meet warranty requirements.

B. Qualifications

1. Manufacturers

- a. Manufacturer to show minimum of thirty (30) years of experience in manufacturing electric self-regulating heating cables.
- b. Manufacturer will be ISO-9001 registered.
- c. Manufacturer to provide heating cable consistent with IEEE 515.1 requirements.
- d. The self-regulating heating cable shall be qualified and tested to demonstrate a useful lifetime in excess of 20 years.
- e. The manufacturer shall provide an extensive global reference list for this application, including installations that have been in operation for over 15 years.

2. Installers

- a. System installer shall have complete understanding of product and product literature from manufacturer or authorized representative prior to installation. Electrical connections shall be performed by a licensed electrician.

3. Electrical Components, Devices, and Accessories: Listed and labelled as defined in NFPA 70, Article 100, by a Nationally Recognized Testing Laboratory (NRTL), and marked for intended use.

C. Certifications

1. The system (heating cable, connection kits, and controller) shall be UL Listed, CSA Certified for roof and gutter de-icing.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery And Acceptance Requirements

1. Deliver, store and handle products to prevent their deterioration or damage due to moisture, temperature changes, contaminates or other causes.
2. Deliver products to site in original, unopened containers or packages with intact and legible manufacturers' labels identifying the following:
 - a. Product and Manufacturer
 - b. Length/Quantity
 - c. Lot Number
 - d. Installation and Operation Manual
 - e. MSDS (if applicable)

B. Storage And Handling Requirements

1. Store the heating cable in a clean, dry location with a temperature range 0°F (-18°C) to 140°F (60°C).
2. Protect the heating cable from mechanical damage.

1.7 WARRANTY

A. Manufacturer Warranty

1. Warrant all goods listed below for two (2) years from date of purchase against faulty workmanship and use of defective materials when such goods are properly installed, operated, and maintained according to product documentation.
 - a. Panels, heating cables, connection kits & accessories
 - b. Thermostats, controllers, panels contactors, sensors and accessories

B. Special Warranty:

1. Contractor shall provide the owner an extended product warranty for the heat tracing products listed below. The contractor must complete and forward to owner the Installation, Inspection or Commissioning Record(s) located in the back of installation manual for the heat trace system being installed, and complete the online warranty registration form at www.pentairthermal.com within thirty (30) days from the date of installation, otherwise only standard limited warranty applies. See Limited Product Warranty Extension details (H57397) at www.pentairthermal.com
 - a. Heating Cable, Panels & Components = Warranty Twenty (20) Years from Date of Purchase

2. Warranty information must be published on the manufacturer's website.

PART 2 - PRODUCTS

2.1 HEAT TRACING SYSTEM

A. Manufacturers

1. Basis of Design Manufacturer: Subject to the compliance with requirements, provide Raychem heat tracing products of Pentair Thermal Building Solutions, Redwood City 94063, 800-545-6258;
2. Submit comparable products of one of the following for approval by the specifier:
 - a. Submit request for substitutions in accordance with Instructions to Bidders and Division 01 General Requirements.

B. Materials

1. Roof Ice Melt panels shall be Raychem RIM2 -LPE System for System for moderate or light snow load areas.
 - a. The roof ice melt panels consist of Aluminum extrusions with channels designed to fit the self-regulating heating cables. To prevent roof damage, the extrusions shall not have any protrusions perpendicular to roof surface.
 - b. The roof ice melt panels specifically designed for Eaves, Valleys, Channels, Rakes, and low pitch roof sections.
2. Heating cables shall be Raychem IceStop OR WFP, self-regulating heating cables specifically designed for this application.
 - a. The construction of the self-regulating heating cable shall consist of a continuous core of conductive polymer that is radiation crosslinked, extruded between two (2) 16 AWG nickel-plated copper bus wires that varies its power output in response to panel temperature changes.
 - b. The heating cable shall have a modified polyolefin inner jacket for dielectric integrity long life expectancy.
 - c. The heating cable shall have a (5/24) tinned copper braid with minimum 70% coverage for ground path and mechanical ruggedness.
 - d. The heating cable shall have a POLYOLEFIN outer jacket printed with cable model #, agency listings, batch number and meter marks (for ease of installation within maximum circuit length.
 - e. The heating cable shall have a self-regulating factor of at least 70 percent. The self-regulating factor is defined as the percent reduction of the heating cable power output going from a 0°F to 80°F roof temperature.

- f. The heating cable shall operate on line voltages of 208 volts without the use of transformers.
 - g. The heating cable shall be part of a UL Listed system.
 - h. Constant wattage cables are not acceptable.
- 3. Heating Cable Connection Kits
 - a. The heating cable circuits shall be connected to the power wiring in an approved junction box with approved termination components.
 - b. Manufacturer shall provide power connection, splice/tee and end seal kits compatible with selected heating cable.
 - c. Connection kits shall be UL Listed .
- 4. Energy Efficient Control System
 - a. Option 1 - Single Circuit Local Digital Control System
 - 1) All self-regulating heating cables shall be controlled via an energy saving, programmable single circuit controller to provide adjustable maintained temperatures in the range of 40°F to 140°F (40°C to 60°C), known as Raychem C910-485, manufactured by Pentair.
 - 2) The controllers shall provide 30mA ground-fault protection as required by code. Ground-fault setting shall be non-adjustable.
 - 3) The controller shall be microprocessor based control system with integrated equipment ground fault protection.
 - 4) Control user interface includes LED displays and function keys that make it easy to use and program. No additional hand-held programming devices shall be needed.
 - 5) Alarm conditions and programming settings shall be easy to interpret on the full-text front panel. Settings shall be stored in nonvolatile memory in the event of power failure.
 - 6) The controller shall have both an isolated solid-state triac relay and a dry contact relay for alarm annunciation back to a building management system (BMS).
 - 7) The controller shall include a RS-485 communication module to remotely configure, control and monitor the heating cable circuits through a building management system (BMS).
 - 8) The controller should include auto-cycle tests feature to verify heat trace and RIM system integrity at a user defined interval.
 - 9) Controller shall have NO/NC alarm contacts. Controller shall alarm on:
 - a) Loss of power
 - b) Ground fault warning
 - c) Ground fault trip
 - d) Low current
 - 10) Digital controller shall be UL Listed .

11) Approval

- a) The system (heating cable, connection kits, and controller) shall be UL Listed, for roof & gutter de-icing.
- b) The roof & gutter de-icing system shall have a design, installation and operating manual specific to roof & gutter de-icing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Preinstalling Testing

- 1. Prior to installing heating cable on the roof, an insulation resistance test shall be performed by the installing contractor to ensure integrity of heating cable as described in the installation & maintenance manual.

3.2 PREPARATION

A. Protection Of In-Place Conditions

- 1. All heating cable ends shall be protected from moisture ingress until cable is terminated.

3.3 INSTALLERS

A. Acceptable Installers

- 1. Subject to compliance with requirements of Contract Documents, installer shall be familiar with installing heat-trace cable and equipment

3.4 INSTALLATION

- A. Comply with manufacturer's recommendations in the RIM / RIM-2 System heating cable and connection kits Installation and operation manuals.
- B. Install and secure the system in accordance with the RIM /RIM-2 System Installation and Operation Manuals.
- C. Install electric heating cable according to the drawings and the manufacturer's instructions. The installer shall be responsible for providing a complete functional system, installed in accordance with applicable national and local requirements.

- D. Grounding of the system shall be done according to Section 26 05 26 "Grounding and Bonding for Electrical Systems." Heating cable braid must be connected to appropriate ground.
- E. Connection of all electrical wiring shall be according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Initial start-up and field testing (commissioning) of the system shall be performed by factory technician or factory representative per the owner's requirements.
- B. Field Tests And Inspections
 - 1. The system shall be commissioned in accordance to the RIM System Installation and Operation manual.
 - 2. The heating cable circuit integrity shall be tested using a 2500 Vdc megohmmeter at the following intervals below. Minimum acceptable insulation resistance shall be 1000 megohms or greater.
 - a. Before installing the heating cable
 - b. After heating cable has been installed in the RIM panels
 - c. After installing connection kits
 - d. Prior to initial start-up (commissioning)
 - e. As part of the regular system maintenance
 - 3. The technician shall verify that the controller parameters are set to the application requirements.
 - 4. "The technician shall verify that the ACS-30 and ProtoNode device server (if applicable) are configured correctly with the BMS."
 - 5. All commissioning results will be recorded and presented to the owner.
- C. Non-Conforming Work
 - 1. Any heat tracing circuit which fails the any of the above test must be corrected prior to commissioning or startup of the system.

3.6 SYSTEM STARTUP

- A. Provide a factory-certified technician or manufacturer's representative for startup & commissioning of the heat tracing system and controller.
- B. Coordinate all controller settings with engineer prior to programming the controller.
- C. Provide commissioning report in submittals package to owner.

3.7 MAINTENANCE

A. Maintenance Service

1. Comply with manufacturer's recommendations in RIM System Installation and Operation Manual.

END OF SECTION

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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. Rail-type, seam-mounted snow guards.

1.3 ACTION SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for snow guards.
- B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.
 - 1. Include details of rail-type snow guards.
 - 2. Include calculation of number and location of snow guards based on snow load, roof slope, roof type, components, spacings, and finish.
- C. Samples: Base, bracket, and 12-inch- long rail.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of snow guard, for tests performed by manufacturer and witnessed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. 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, ambient; 180 deg F, material surfaces.

B. Structural Performance:

1. Snow Loads: As indicated on Drawings.

2.2 RAIL-TYPE SNOW GUARDS

A. Seam-Mounted, Rail-Type Snow Guards:

1. Basis-of-Design Product: Subject to compliance with requirements, provide S5!; DUALGUARD or comparable product by one of the following:
 - a. Metal Roof Innovations, Ltd.
2. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with two rails.
3. Components:
 - a. Clamps - Manufactured from 6061-T6 aluminum extrusions conforming to ASTM B221 or aluminum castings conforming to ASTM B85 and to AA Aluminum Standards and Data.
 - 1) Model: No. S-5-V Mini.
 - 2) Set screws: 300 Series stainless steel, 18-8 alloy, 3/8 inch diameter, with round nose point.
 - 3) Attachment bolts: 300 Series stainless steel, 18-8 alloy, 8 mm diameter, hex flange bolt.
 - b. Pipe Brackets:
 - 1) Manufactured from 5000 Series alloy and temper aluminum conforming to ASTM B221 and AA Aluminum Standards and Data.
 - c. Pipe Couplings (Splices):
 - 1) Manufactured from 6005a-T61 Series alloy and temper aluminum extrusions conforming to ASTM B221 and AA Aluminum Standards and Data.
 - d. Pipes (Cross Members):
 - 1) Manufactured 6005a-T61 Series alloy and temper aluminum extrusions conforming to ASTM B221 and AA Aluminum Standards and Data.
 - a) Model: DualPipe

e. Pipe Collar:

- 1) Manufactured from 6005a-T61 Series alloy and temper aluminum extrusions conforming to ASTM b221 and AA Aluminum Standards and data, with 1/4-20 x 3/8 inch stainless steel set screw.

- a) Model: DualCollar

f. Snow and Ice Clips:

- 1) Aluminum, with rubber foot, minimum 3 inches wide.

- a) Model: DualClip III for standing seam heights 1.75 inch to 3.25 inch.

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. 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. Pre-assemble one S-5! Mini clamp to each pipe bracket assuring the set screws are facing the correct side of the standing seam they will be applied to. Attach S-5! Mini clamps to pipe brackets on what will become the upslope side of the assembly. Hand tighten M8 bolt fastening S-5! Mini clamp to pipe bracket. Pre-load set screws into clamps.
3. Insert pipes into pre-assembled upslope pipe bracket and S-5! Mini clamp assemblies. Insert a pipe collar inside last bracket of either end of the run as pipe is inserted into brackets.
4. Place downslope clamps on standing seams at maximum 48 inches on center or as required by in-service loads.
5. Place downslope clamps in straight, aligned rows using a string line.
6. Some clamps are directional. Reference installation instructions for the specific clamp used to assure they are oriented correctly.
7. Tighten downslope clamp set screws to manufacturers recommended torque. Test set screw torque using calibrated torque wrench.
8. Attach pre-assembled upslope row of S-5! Mini clamps with attached pipe brackets and pipes aligning with downslope clamps. Tighten M8 bolt to fasten pre-assembly on downslope clamps to recommended torque of 156 inch pounds (13 foot pounds) (17.63 Newton meters)
9. Tighten upslope clamp set screws to standing seams to manufacturers recommended torque. Test set screw torque using calibrated torque wrench. Then, tighten M8 bolt on upslope clamps to recommended torque of 156 inch pounds. (13 foot pounds) (17.63 Newton meters)
10. Install pipe coupling at adjoining pipe end joints. Insert coupling halfway into pipe that will be joined to next pipe in the run.
11. Cut extended end of pipe at end of run. Do not cantilever pipes more than 4 inches beyond last clamp and bracket at ends.
12. Apply end cap to each pipe.
13. Install two DualClips per panel between panel seams.
 - a. DualClips: Secure DualClip III to back side of cross member using stainless steel #10 x ½ inch screw

END OF SECTION 07 72 53

SECTION 07 81 00 - APPLIED FIREPROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes cementitious sprayed fire-resistive materials.

1.2 DEFINITIONS

- A. Sprayed fire-resistive material is applied to surfaces that are concealed from view behind other construction when the Work is completed or that are exposed to view in locations where they will not be physically abused meaning that the materials are not in contact with end user or end user's equipment causing dislocation or reduction in required thickness of material.

1.3 COORDINATION

- A. Sequence and coordinate application of sprayed fire-resistive materials with other related work specified in other Sections to comply with the following requirements:
 - 1. Provide temporary enclosures for interior applications to prevent deterioration of fire-resistive material due to exposure to unfavorable environmental conditions.
 - 2. Avoid unnecessary exposure of fire-resistive material to abrasion and other damage likely to occur during construction operations subsequent to its application.
 - 3. Do not apply fire-resistive material to metal roof deck substrates until concrete fill, if any, and roofing has been completed; prohibit roof traffic during application and drying of fire-resistive material.
 - 4. Do not apply fire-resistive material to metal floor deck substrates until concrete fill has been completed.
 - 5. Do not begin applying fire-resistive material until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
 - 6. Defer installing ducts, piping, and other items that would interfere with applying fire-resistive material until application of fire protection is completed.
 - 7. Do not install enclosing or concealing construction until after fire-resistive material has been applied, inspected, tested and corrections have been made to defective applications.

1.4 ACTION SUBMITTALS

- A. Product Data: Submit current edition of manufacturer's application and installation instruction manual and referenced bulletins.

- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Shop Drawings: Submit a "Fire-Resistive Materials Design Schedule Keyed to the Structural Drawings and Schedules" indicating the following:
 - 1. Schedule for each building element receiving spray fire-resistive materials showing hourly rating and material thickness and UL Design Number.
 - 2. When UL Designs are used for beams and columns smaller and larger than those listed in the UL Design, provide explanation of thickness adjustment based on W (weight per lineal foot)/D (perimeter of exposure) formulas for each element.
 - 3. Locations and types of surface preparations required before applying sprayed fire-resistive material.
 - 4. Extent of sprayed fire-resistive material for each construction and fire-resistance rating, including a schedule indicating the following:
 - a. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
 - b. Minimum thicknesses needed to achieve required fire-resistance ratings of structural components and assemblies.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installer.
- B. Product Certificates: For each type of fireproofing.
- C. Evaluation Reports: For fireproofing, from ICC-ES.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer certified, licensed, or otherwise qualified by sprayed fire-resistive material manufacturer as having the necessary experience staff, and training to install manufacturer's products according to specified requirements. A manufacturer's willingness to sell its sprayed fire-resistive materials to Contractor or to an installer engaged by Contractor does not in itself confer qualification on the buyer.
- B. Fire-Test-Response Characteristics: Provide sprayed fire-resistive 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. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency acceptable to authorities having jurisdiction, for sprayed fire-resistive material serving as direct-applied protection tested per ASTM E 119.
 2. Surface-Burning Characteristics: ASTM E 84.
- C. Pre-Installation Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Contractor, installer and independent testing agency shall attend a pre-installation conference to review the substrates for acceptability, method of application, applied thicknesses, and testing and inspection procedures.
- D. Regulatory Requirements: Conform to the applicable building code requirements of the authorities having jurisdiction. Products, execution, and the thickness spray fire resistive materials shall conform to the applicable code requirements for the required fire resistance ratings.
1. UL Degree of Restraint: Unrestrained.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to Project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, shelf life if applicable, and fire-resistance ratings applicable to Project.
- B. Use materials with limited shelf life within period indicated. Remove from Project site and discard materials whose shelf life has expired.
- C. Store materials inside, under cover, aboveground, in a dry location, until ready for use. Remove from Project site and discard wet or deteriorated materials.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply sprayed fire-resistive material when ambient or substrate temperatures are 40 deg F or lower. When ambient or substrate temperatures are lower, provide temporary enclosures and heat to maintain temperatures at or above this level for 24 hours before and during application, and after application for a minimum of 24 hours or more, until the sprayed fire resistive material is cured.
- B. Ventilation: Ventilate spaces during and after application of sprayed fire-resistive material. Provide a minimum of 4 air changes per hour until fire resistive material cures by the following:
 1. Using natural means.

2. When natural means are inadequate, provide forced-air circulation at a rate of 4 air exchanges per hour.

1.9 WARRANTY

- A. Special Warranty: Submit a written warranty, signed by Contractor and by Installer, agreeing to repair or replace sprayed fire-resistive materials that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
 1. Failures include, but are not limited to, cracking, flaking, or eroding by air or weather, in excess of specified requirements; peeling; and delaminating of sprayed fire-resistive materials from substrates due to defective materials and workmanship.
 2. Not covered under the warranty are failures due to damage by occupants and Owner's maintenance personnel, exposure to environmental conditions other than those investigated and approved during fire-response testing, and other causes not reasonably foreseeable under conditions of normal use.
- B. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. VOC Content: For field applications, coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
 1. Primers, Sealers, and Undercoaters: 100 g/L.

2.2 SPRAYED FIRE-RESISTIVE MATERIALS

- A. General: Provide manufacturer's standard products complying with requirements indicated for material composition and physical properties representative of installed products.
- B. Subject to compliance with requirements, provide products by one of the following:
 1. Cementitious (Gypsum) Sprayed Fire-Resistive Material for interior locations, concealed conditions, in buildings less than 75 ft. tall:
 - a. Carbolite Co., Fireproofing Products Div.; Pyrolite 15.
 - b. GCP Applied Technologies (Grace, W. R. & Co., Construction Products Div.); Monokote Type MK-6.
 - c. Isolatek International Corp., Cafco Products; Cafco 300.
 - d. Southwest Fireproofing Products Co.; 5GP.
 - e. Carbolite Co., Fireproofing Products Div.; Pyrolite 22.

- f. GCP Applied Technologies (Grace, W. R. & Co., Construction Products Div.); Monokote Type Z-106.
 - g. Isolatek International Corp., Cafco Products; Cafco 400.
 - h. Southwest Fireproofing Products Co.; 7GP.
- C. Material Composition: Cementitious sprayed fire-resistive material consisting of factory-mixed, dry formulation of gypsum or portland cement binders and lightweight, asbestos free, mineral or synthetic aggregates mixed with water at Project site to form a slurry or mortar for conveyance and application.
- D. Physical Properties: Minimum values, unless otherwise indicated, or higher values required to attain designated fire-resistance ratings, measured per standard test methods referenced with each property as follows:
 - 1. Dry Density: 15 lbs./cu. ft. typically for average and individual densities regardless of density indicated in referenced fire-resistance design, or greater if required to attain fire-resistance ratings indicated, per ASTM E 605/E 605M.
 - 2. Thickness: Provide minimum average thickness required for each fire-resistance design indicated according to ASTM E 605/E 605M.
 - 3. Bond Strength: 200 lbf/sq. ft. minimum per ASTM E 736/E 736M:
 - a. If surfaces of structural steel receiving sprayed fire-resistive material are primed or otherwise painted for coating materials, perform series of bond tests specified in UL's "Fire Resistance Directory." Provide bond strength indicated in referenced UL fire-resistance criteria.
 - 4. Air Erosion: Maximum weight loss of 0.001 g/sq. ft. in 24 hours per ASTM E 859.
 - 5. Fire-Test-Response Characteristics: Provide sprayed fire-resistive materials with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - a. Flame-Spread Index: 10 or less.
 - b. Smoke-Developed Index: 0.

2.3 AUXILIARY FIRE-RESISTIVE MATERIALS

- A. General: Provide auxiliary fire-resistive materials that are compatible with sprayed fire-resistive materials and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
- B. Adhesive for Bonding Fire-Resistive Material: Product approved by manufacturer of sprayed fire-resistive material.

- C. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required to comply with fire-resistance designs indicated and fire-resistive material manufacturer's written recommendations. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive sprayed fire-resistive material.
- D. Water: Potable. Provide water with sufficient pressure and volume to meet the fireproofing application schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with installer and representative of the testing laboratory present, to determine that they are in satisfactory condition to receive sprayed fire-resistive material. Contractor, Installer and testing laboratory shall submit written statement of each area's substrate acceptability to the Architect prior to beginning application of fire-resistive materials. A substrate is in satisfactory condition if it complies with the following:
 - 1. Substrates comply with requirements in the Section where the substrate and related materials and construction are specified.
 - 2. Substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt, and other foreign substances capable of impairing bond of fire-resistive material with substrate under conditions of normal use or fire exposure.
 - 3. Objects penetrating fire-resistive material, including clips, hangers, support sleeves, and similar items, are securely attached to substrates prior to application.
 - 4. Substrates are not obstructed by ducts, piping, equipment, and other suspended construction that will interfere with applying fire-resistive material.
- B. Prior to application of fireproofing to steel beams and decks verify that placement of concrete fill on floor and roof decks has been completed.
- C. On roof decks without concrete fill complete all roofing applications and roof mounted equipment installation prior to application of fireproofing to the underside of supporting beams.
- D. Do not proceed with installation of fire resistive materials until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of substances that could impair bond of fire-resistive material, including dirt, oil, grease, release agents, rolling compounds, loose mill scale, and incompatible primers, paints, and other foreign substances which may impair proper adhesion of fireproofing to substrate.

- B. Metal Lathing: Where required by rated assembly and bond, install metal lath, as required, to comply with fire-resistance ratings and fire-resistive material manufacturer's written recommendations for conditions of exposure and intended use. Securely attach lath to substrate in position required for support and reinforcement of fire-resistive material. Use anchorage devices of type recommended in writing by sprayed fire-resistive material manufacturer. Attach lathing accessories where indicated or required for secure attachment to substrate.
- C. Cover other work subject to damage from fallout or overspray of fire-resistive materials before application. Provide temporary enclosure as required to confine spraying operations, protect the environment, and ensure maintenance of adequate ambient conditions for temperature and ventilation.
 - 1. Cover floor slabs with polyethylene sheeting.

3.3 INSTALLATION, GENERAL

- A. Comply with fire-resistive material manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and spray on fire-resistive material, as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
- B. Extend fire-resistive material in full thickness over entire area of each substrate to be protected. Unless otherwise recommended in writing by sprayed fire-resistive material manufacturer, install body of fire-resistive covering in a single course.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to verify the adequacy of the Contractor's quality control of the sprayed-fire resistive materials work.
 - 1. The independent testing and inspection agency will promptly submit weekly test results to the Contractor and Architect in the form required under ASTM E 605/E 605M and E 736/E 736M. The reports shall clearly indicate the location of each test, the test result at that location, and whether or not the tested fire resistive materials at each test location complies with the Contract Documents.
- B. Testing and Inspection: Testing and inspection of completed applications of sprayed fire-resistive material shall be conducted as the work progresses. Each thickness, density and bond strength test location shall be selected at random by the testing and inspection agency. Do not proceed with application of sprayed fire-resistive material for the next area until test results for previously completed applications of sprayed fire-resistive material show compliance with requirements.

1. Visual Inspection:
 - a. Prior to Application: Visually inspect all surfaces intended to receive sprayed fire resistive materials prior to its installation for conformance with the requirements of the Contract Documents.
 - b. After Application: Visually inspect all surfaces that received sprayed fire resistive materials, including patched areas, for conformance with the requirements of the Contract Documents. Cracks in the fireproofing which expose the fireproofed substrate will not be permitted.
 - c. Final Inspection: After the work of adjacent trades has been completed, but before sprayed structural elements are enclosed, conduct a final visual inspection of sprayed-fire resistive materials work.
2. Thickness Testing:
 - a. Thickness for Floor and Roof Deck Assemblies: For each 1000 sq. ft. area, or partial area, on each floor, make four random tests for thickness per ASTM E 605/E 605M. Thickness measurements shall be selected from a square area 12 inches by 12 inches in size. For fluted decks a minimum of four measurements shall be made, located symmetrically within the square area including one each of the following: valley, crest and sides. The average of the measurements shall be reported.
 - b. Thickness for Beams, Girders, Joists, Trusses and Columns: One test for beams, girders, joists or trusses, and one test for columns, per 25 percent of structural members per floor per ASTM E 605/E 605M.
 - 1) At beams and girders thickness measurements shall be made at nine locations around the beam or girder at each end of a 12 inch length.
 - 2) At joists and trusses, thickness measurements shall be made at seven locations around the joist or truss at each end of a 12 inch length.
 - 3) At wide flange columns, thickness measurements shall be made at twelve locations around the column at each end of a 12 inch length.
 - 4) At hollow structural section and pipe columns, thickness measurements shall be made at a minimum of four locations around the column at each end of a 12 inch length.
3. Density Testing: For each 2,500 sq. ft. area, or partial area, on each floor, test one protected beam, one protected girder, one protected truss, one protected column, and one protected deck surface per ASTM E 605/E 605M.
4. Cohesion-Adhesion (Bond Strength) Testing: For each 2,500 sq. ft. area, or partial area, on each floor, test one protected beam, one protected column, and one protected deck surface, for cohesion and adhesion per ASTM E 736/E 736M.
5. Where testing and inspection reveals applications of sprayed fire-resistive material are not in compliance with requirements, testing and inspecting agency will perform additional random testing to determine extent of noncompliance.

- C. Apply additional sprayed fire-resistive material per manufacturer's written instructions where test results indicate that thickness does not comply with specified requirements.
- D. Remove and replace, at Contractor's expense, including costs of delays to the work caused by removal and replacement, sprayed fire-resistive material where test results indicate that they do not comply with specified requirements for both cohesion and adhesion and for density.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.5 CLEANING, PROTECTING, AND REPAIR

- A. Cleaning: Immediately after completing spraying operations in each confinable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces.
- B. Cure exposed cementitious-sprayed fire-resistive material according to product manufacturer's written recommendations to prevent premature drying.
- C. Protect sprayed fire-resistive material, according to advice of product manufacturer and Installer, from damage resulting from construction operations or other causes so fire protection will be without damage or deterioration at time of Substantial Completion.
 - 1. Trades, other than fireproofing installer, who remove fireproofing material will be responsible for replacement of same.
- D. Coordinate application of sprayed fire-resistive material with other construction to minimize need to cut or remove fire protection. As installation of other construction proceeds, inspect sprayed fire-resistive material and patch any damaged or removed areas prior to covering by other construction.

END OF SECTION 07 81 00

SECTION 07 84 13 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items:
 - 1. Floors.
 - 2. Roofs.
 - 3. Walls and partitions.
 - 4. Smoke barriers.

1.2 ACTION SUBMITTALS

- A. Product Data: Submit product data for each type of through penetration firestop system product indicated.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Through-Penetration Firestopping Schedule: Submit a Through-Penetration Firestopping Schedule indicating the type of through-penetration firestop system to be installed for each penetration. Indicate each kind of construction condition penetrated and kind of penetrating item. Include firestop design designation of testing and inspection agency acceptable to the authorities having jurisdiction that evidences compliance with requirements for each condition indicated.
 - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.
 - a. Engineering judgment shall include both project name and contractor's name who will install firestop system as described in document

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual certified or licensed, by firestop system manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements. A manufacturer's willingness to sell its firestop system materials to Contractor or to an installer engaged by Contractor does not in itself confer qualification on the buyer.
 - 1. The installer must have no less than 3 years of experience with fire stop installation.
- B. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer; date of manufacture; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multi-component materials.
- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet.
- B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.
- C. Notify Owner's inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.
- D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until Architect, Owner's inspecting agency and building inspector, if required by authorities having jurisdiction, have examined each installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 - 1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.
 - 1) UL in its "Fire Resistance Directory."

2.2 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
 2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
 3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.
- D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg.
1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.
- E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.
1. Sealant shall have a VOC content of 250 g/L or less.
- F. Provide non-hardening resilient firestop material at penetrations, sleeves and passthroughs in acoustic construction assemblies.
1. Acceptable Products:
 - a. Specified Technologies, Inc.; Elastomeric Sealant ES100
 - b. Johns Manville; Firetemp CI Caulk.
 - c. 3M; Fire Barrier 2001 Silicone RTV Foam.
 - d. Hilti; Flexible Firestop Sealant CP 606.

2.3 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.
- E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.

- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable, heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
- K. Gypsum Products: The use of gypsum products for through-penetration firestopping is strictly prohibited.

2.4 MIXING

- A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without damaging substrate or disturbing firestop system's seal with substrates.

3.3 INSTALLATION

- A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.
- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and installations comply with requirements.

3.5 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

END OF SECTION 07 84 13

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes sealants for the following applications:
1. Exterior joints in the following vertical surfaces and nontraffic horizontal surfaces:
 - a. Control and expansion joints in unit masonry.
 - b. Joints in stone cladding.
 - c. Joints between different materials listed above.
 - d. Perimeter joints between materials listed above and frames of doors and windows and louvers.
 - e. Other joints as indicated.
 2. Exterior joints in the following horizontal traffic surfaces:
 - a. Control, expansion, and isolation joints in cast-in-place concrete slabs.
 - b. Around perimeters of parking garage and balcony deck drains.
 - c. Joints between different materials listed above.
 - d. Other joints as indicated.
 3. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Vertical control joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
 - d. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
 - e. Other joints as indicated.
 4. Interior joints in the following horizontal traffic surfaces:
 - a. Control and expansion joints in cast-in-place concrete slabs.
 - b. Other joints as indicated.
- B. Single Subcontract Responsibilities: Refer to Section 08 44 13 "Glazed Aluminum Curtain Walls," for requirements applicable to single subcontract responsibility.

1.2 ACTION SUBMITTALS

- A. Product Data: Submit product data for each joint-sealant product indicated and the following:
 - 1. Written certification from manufacturers of joint sealants attesting that their products comply with specification requirements and are suitable for the use(s) indicated as verified through manufacturer's in-house testing laboratory.
 - a. Complete instructions for handling, storage, mixing, priming, installation, curing and protection of each type of sealant.
 - 2. Laboratory and field test results confirming joint preparation (cleaning/priming), chemical compatibility, and proper adhesion for specified joint sealant for each of the joint profiles and substrate materials included in the design of this Project.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Samples: Submit samples of each type and color of exposed joint sealant required. Provide fully cured joint sealant samples in 3/4 inch wide joints 12 inches long formed between two strips of material to be sealed as they will appear on the Project.

1.3 INFORMATIONAL SUBMITTALS

- A. Warranties: Submit specified warranties.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Exposed sealant work including, but not limited to, sealants used for air and weatherseals which are external to [curtain wall systems at their perimeter,][metal panel to panel joints at their perimeter,][skylights,][sloped glazing,][architectural precast to precast joints,][exterior stone cladding joints,] [face brick to face brick joints] shall be performed by one firm specializing in the installation of sealants who has successfully produced work comparable to this Project, in not less than three projects of similar scope to the satisfaction of the Architect, and whose work has resulted in construction with a record of successful in-service performance for a period of 10 years. Concealed sealant work (sealants which are internal to [curtain wall systems,] [metal panels,][skylights,][sloped glazing] [necessary for air and moisture penetration resistance under applied loads) shall be the responsibility of the subcontractor responsible for the final design, installation, and performance of the respective system.
- B. Source Limitations: Obtain each type of joint sealant, and each type of structural silicone adhesive, from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.
- B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.7 WARRANTY

- A. Special Installer's Warranty: Written warranty, signed by Installer agreeing to repair or replace elastomeric joint sealant work which has failed to provide a weathertight system within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- B. Special Manufacturer's Warranties: Written warranties (weatherseal and stain resistance), signed by elastomeric sealant manufacturer agreeing to furnish elastomeric joint sealants to repair or replace those that fail to provide airtight and watertight joints, or fail in adhesion, cohesion, abrasion-resistance, stain-resistance, weather resistance, or general durability or appear to deteriorate in any other manner not clearly specified in the manufacturer's data as an inherent quality of the material within specified warranty period.
 - 1. Warranty Period:
 - a. For Polyurethane Sealants: 5 years from date of Substantial Completion.
 - b. For Silicone Sealants: 20 years from date of Substantial Completion.

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 stated by sealant manufacturer's published data, and as substantiated by the manufacturer for each application through testing.
- 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, Subpart D (EPA Method 24):
 - 1. Architectural Sealants: Not more than 250 g/L.
 - 2. Nonmembrane Roof Sealants: 300 g/L.
 - 3. Single-Ply Roof Membrane Sealants: 450 g/L.
 - 4. Sealant Primers for Nonporous Substrates: Not more than 250 g/L.
 - 5. Sealant Primers for Porous Substrates: Not more than 775 g/L.
- C. Low-Emitting Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Colors: For fully concealed joints, provide manufacturer's standard color of sealant which has the best overall performance characteristics for the application shown. For exposed joints provide color as selected manufacturers standard colors
- E. Manufacturer's Representative: Do not use elastomeric sealant produced by a manufacturer who will not agree to send a qualified technical representative to the Project site when requested, for the purpose of rendering advice concerning the proper installation of manufacturer's materials.

2.2 ELASTOMERIC JOINT SEALANTS

- A. Silicone Sealants for Vertical Applications (Non-Sag):
 - 1. Typical Exterior Wall Joints:
 - a. Properties:
 - 1) Standards: Comply with ASTM C 920, Type M or S, Grade NS, Class 25 or 50; use NT, M, A and O.

- 2) Performance: Non-stain, non-bleed, non-streaking to sealed and adjacent substrates. The minimum peel adhesion value after 7 day immersion shall not be less than 13 pli when tested in strict accordance with ASTM C 794 Adhesion in Peel.
 - 3) Cure System and Oil Content: Neutral-cure, low or medium modulus system specifically manufactured with controlled oil content to eliminate oil migration into sealed substrates and residue rundown over and onto adjacent substrates.
 - b. Products and Manufacturers: One of the following:
 - 1) DOWSIL 756 SMS; Dow Chemical Company.
 - 2) 890 NST; Pecora.
- B. Two Part Polyurethane Sealants for Vertical Applications (Non-Sag):
 1. Typical Exterior Wall Joints (Two-Part Polyurethane Sealants):
 - a. Properties:
 - 1) Standards: Comply with ASTM C 920, Type M, Grade NS, Class 25 or Class 50; use NT, M, A and O.
 - 2) Performance: Non-stain, non-bleed, non-streaking to sealed and adjacent substrates. The minimum peel adhesion value after 7 day immersion shall not be less than 13 pli when tested in strict accordance with ASTM C 794 Adhesion in Peel.
 - b. Products and Manufacturers: One of the following:
 - 1) BASF Master Builders; MasterSeal NP 2.
 - 2) Pecora Corporation; Dynatrol II.
 - 3) Tremco an RPM Co.; 240FC.
- C. Two-Part Polyurethane Sealant for Paving and Non-Immersed Swimming Pool Applications:
 1. For Paving Applications with Slopes not Exceeding 5% (Self Leveling): ASTM C 920, Type M, Grade P, Class 25; use T (except with a Shore A hardness of 35 or greater) and I (Class 1 or 2) for water immersion; and abrasion resistant, one of the following:
 - a. Pecora Corporation; Urexpand NR-200.
 - b. Tremco, an RPM Co.; Vulkem, 445SSL.
 - c. Sika; Sikaflex 2c SL.
 2. For Paving Applications with Slopes Exceeding 5%: ASTM C 920, Type M, Grade P "Slope Grade," Class 25; uses T (except with a Shore A hardness of 35 or greater) and abrasion resistant; one of the following:

- a. Pecora Corporation; Dynatred.
- b. Tremco, an RPM Co.; Vulkem, 445SSL
- c. Sika; Sikaflex 2c NS TG.

2.3 LATEX JOINT SEALANTS

- A. Latex Sealant: Non-elastomeric, one part, non-sag, paintable latex sealant that is recommended for exposed applications on the interior. Complying with ASTM C 834, Type OP (opaque sealants):
 - 1. Products: Provide one of the following:
 - a. Pecora Corporation; AC-20 + Silicone.
 - b. DAP Products Inc.; Alex Plus Acrylic Latex Caulk Plus Silicone.
 - c. BASF; MasterSeal NP 520.
 - d. Tremco, an RPM Co.; Tremflex 834.

2.4 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type 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: One of the following preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding backings of flexible plastic foam complying with ASTM C 1330, and of type indicated below. Select shape and density of cylindrical sealant backings in consultation with the manufacturer for proper performance in specific condition of use in each case.
 - 1. Type C: Closed-cell polyethylene foam material with a surface skin, which is nonabsorbent to liquid water and gas, non-outgassing in unruptured state; one of the following:
 - a. HBR Closed Cell Backer Rod; Nomaco, Inc.
 - b. MasterSeal 920; BASF Master Builders.
 - c. Mile High Foam; Backer Rod Mfg., Inc.
- C. Bond-Breaker Tape: Polyethylene, TFE fluorocarbon, 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 where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.
- D. Weep and Vent Tubes: Clear plastic (PVC) tubing, minimum 1/4 inch inside diameter, and of length as required to extend between exterior face of sealant and open cavity behind.

1. At window and curtain wall systems, where required by system designer, provide gutter termination of tube with preformed nipples suitable for sealing to gutter.

2.5 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended, as verified through compatibility and adhesion testing, by joint sealant manufacturer for the substrates indicated to be sealed.
- 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 with joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and which will not stain nor mar the finish of surfaces adjacent to joints to which it is applied.

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. 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 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), existing joint sealants, existing backer rods, existing waterproofing materials, existing water repellent treatments, oil, grease, water, surface dirt, and frost.
 2. Clean concrete, masonry, unglazed surfaces of tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, 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 from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
 3. Remove laitance and form-release agents from concrete.

4. Clean metal, glass, porcelain enamel, glazed surfaces of tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming (Elastomeric Sealants Only): Prime joint substrates with primers selected through the preconstruction compatibility and adhesion testing. 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. Joint Priming (Elastomeric Sealants Only): Prime joint substrates where recommended in writing by joint sealant manufacturer, based on prior testing and 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 beyond bond areas or onto adjoining surfaces.
- D. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant and primer 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.
 1. Silicone Glazing Sealants: Refer to Section 08 80 00 "Glazing" for installation.
- 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. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:
 1. Install sealant backings of type 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.
 - a. Do not leave gaps between ends of sealant backings. Trim for tight fit around obstructions or elements penetrating the joint.
 - b. Do not stretch, twist, puncture, or tear sealant backings.
 - c. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry sealant backings.
 2. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.

3. Install weeps and vents into joints at the same time sealants are being installed. Unless otherwise shown on the drawings, or directed by the Architect, locate weeps and vents spaced as recommended by the sealant manufacturer and the window and curtain wall fabricator and erector. Do not install weeps and vents at outside building corners. Do not install vents at horizontal joints immediately below shelf angles, sills, and through wall flashings.
- D. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.
1. Apply sealants in the depth shown or, if none is shown, apply in accordance with the manufacturer's recommendations and the following general proportions and limitations:
 - a. Apply elastomeric sealants in sidewalk, pavement and similar horizontal joints to a depth equal to 75% of the joint width, but not less than 3/8 inch and not more than 3/4 inch.
 - b. Apply elastomeric sealants, in joints not subject to traffic or other abrasion, to a depth equal to 50% of the joint width, but not less than 1/4 inch and not more than 1/2 inch.
 - c. Apply non-elastomeric sealants to a depth approximately equal to the joint width.
 - d. Fill horizontal traffic bearing joints slightly recessed to avoid direct contact with wheel, and pedestrian traffic. Fill horizontal traffic bearing joints with slope grade polyurethane sealants to a depth approximately equal to the joint width.
 2. Pour self-leveling sealants to a depth approximately equal to the joint width.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform, beads to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces. Tool exposed surfaces of sealants to the profile shown, or if none is shown, tool slightly concave.
1. Use masking tape to protect adjacent surfaces of recessed tooled joints.
 2. Provide a slight wash on horizontal joints where horizontal and vertical surfaces meet.
 3. Against rough surfaces or in joints of uneven widths avoid the appearance of excess sealant or compound by locating the compound or sealant well back into joint wherever possible.

3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field-test exterior wall joint-sealant adhesion to joint substrates as follows:

1. Perform 10 tests for the first 1000 feet of joint length for each type of exposed exterior wall sealant and joint substrate.
 2. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.
- B. Field adhesion testing of sealants shall take place in the presence of a qualified technical representative of the sealant manufacturer.
1. Test Method: Test joint sealants by hand-pull method described below:
 - a. Make knife cuts from one side of joint to the other, followed by two cuts approximately 3 inches long at sides of joint and meeting cross cut at one end. Place a mark 1 inch from cross-cut end of 3 inch piece.
 - b. Use fingers to grasp 3 inch piece of sealant between cross-cut end and 1 inch mark; pull firmly at a 90-degree angle to the joint in the direction of side cuts and hold the sealant in this position for 10 seconds; following the 10 second time duration pull sealant at a 180 degree angle parallel to the joint and hold the sealant in this position for 10 seconds. Pull sealant away from joint to the distance recommended by sealant manufacturer for testing adhesion.
 - c. For joints with dissimilar substrates, check adhesion to each substrate separately. Do this by extending cut along one side, checking adhesion to opposite side, and then repeating this procedure for opposite side.
 2. The sealant manufacturer's qualified technical representative shall record test results, and observations of joint and sealant conditions, in a field adhesion test log.
 3. Repair joint sealants pulled from test area as recommended by sealant manufacturer.
 4. The sealant manufacturer shall provide written documentation of changes in product and/or application method required to address sealant failure, observe and document retesting as required by the Architect, and provide a written statement of compliance with applicable warranties.
- C. Sealants not evidencing adhesive failure from testing will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

3.7 JOINT SEALANT SCHEDULE

- A. Exterior joints in the following vertical surfaces and nontraffic horizontal surfaces:
1. Perimeter joints between storefronts, balcony door, aluminum window, metal framing and adjacent materials: Silicone Sealants for Vertical Applications (Non-Sag), Typical Exterior Wall Joints.
 2. Control and expansion joints in cast-in-place concrete: Silicone Sealants for Vertical Applications (Non-Sag), Typical Exterior Wall Joints.
 3. Control and expansion joints in unit masonry: Silicone Sealants for Vertical Applications (Non-Sag), Typical Exterior Wall Joints.
 4. Joints in stone cladding: Silicone Sealants for Vertical Applications (Non-Sag), Typical Exterior Wall Joints.
 5. Joints between different materials listed above: Silicone Sealants for Vertical Applications (Non-Sag), Typical Exterior Wall Joints.
 6. Perimeter joints between materials listed above and frames of doors and windows and louvers: Silicone Sealants for Vertical Applications (Non-Sag), Typical Exterior Wall Joints.
- B. Exterior joints in the following horizontal traffic surfaces:
1. Control, expansion, and isolation joints in cast-in-place concrete slabs: Two-Part Polyurethane Sealant for Paving Applications.
 2. Around perimeters of parking garage and balcony deck drains: Two-Part Polyurethane Sealant for Paving Applications.
 3. Joints between different materials listed above: Two-Part Polyurethane Sealant for Paving Applications.
- C. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
1. Control and Expansion Joints on Exposed Interior Surfaces of Exterior Walls: Latex sealant.
 2. Perimeter Joints of Exterior Openings Where Indicated: Latex sealant.
 3. Vertical Control Joints on Exposed Surfaces of Interior Unit Masonry and Concrete Walls and Partitions: Latex sealant.

4. Perimeter Joints between Interior Wall Surfaces and Frames of Interior Doors, Windows, and Elevator Entrances: Latex sealant.

END OF SECTION 07 92 00

SECTION 07 95 00 - PLAZA-DECK EXPANSION JOINT SYSTEM

PART 1 - GENERAL

1.1 Work Included

- A. The work shall consist of furnishing and installing expansion joints in accordance with the details shown on the plans and the requirements of the specifications. The joints are proprietary designs utilizing extruded elastomeric seals and flashing sheets, base angles, aluminum side rails, stainless steel retainer caps, anchorage systems and support plates where required.
- B. Related Work
 - 1. Section 03 30 00 "Cast-in-Place Concrete"
 - 2. Section 07 13 26 "Self-Adhered Sheet Waterproofing"
 - 3. Section 07 14 13 "Hot Fluid-Applied Rubberized Asphalt Waterproofing"
 - 4. Section 07 27 26 "Fluid-Applied Membrane Air Barriers"
 - 5. Section 07 62 00 "Sheet Metal Flashing and Trim"
 - 6. Section 07 92 00 "Joint Sealants"

1.2 1.02 Submittals

- A. Template Drawings - Submit typical expansion joint cross-section(s) indicating pertinent dimensioning, general construction, component connections, and anchorage methods.

1.3 Product Delivery, Storage and Handling

- A. Deliver products in each manufacturer's original, intact, labeled containers, pallets or bundles and store under cover in a dry location until installed. Store off the ground, protect from weather and construction activities.

1.4 Acceptable Manufacturers

- A. Basis-of-Design Product: Subject to compliance with requirements, provide; Wabo®WaterTite (WT-200/450 and WT-200/450C) by Watson Bowman Acme Corp., a BASF Company or comparable product.
- B. Alternate manufacturers and their products will be considered, provided they meet the design concept and are produced of materials that are equal to or superior to those called for in the base product specification.

1.5 Quality Assurance

- A. Manufacturer: Shall be ISO-9001:2008 certified and shall provide written confirmation that a formal Quality Management System and Quality Processes have been adopted in the areas of, (but not limited to) engineering, manufacturing, quality control and customer service for all processes, products and their components. Alternate manufacturers will be considered provided they submit written proof that they are ISO 9001:2008 certified prior to the project bid date. Manufacturers in the process of obtaining certification will not be considered.
- B. Warranty: The expansion control system shall be warranted when installed by the manufacturer's factory trained installer. Installation shall be in strict accordance with manufacturer's technical specifications, details, installation instructions and general procedures in effect for normal intended usage and suitable applications under specific design movements and loading conditions.
- C. Manufacturer: Shall have a minimum ten (10) years experience specializing in the design and manufacture of expansion control systems.
- D. Products: Expansion control systems shall be installed with manufacturer's blockout repair and infill materials.
- E. Application: The specified expansion control system(s) shall be installed by the manufacturer's factory trained installer.

PART 2 - PRODUCT

2.1 General

- A. Provide watertight expansion control system that is capable of accommodating multi-directional movement. System shall consist of heavy duty extrusions typically cast into the structure by means of utilizing manufacturer's recommended concrete anchor studs. The aluminum side rail extrusions shall be designed to accept and mechanically lock manufacturer's elastomeric seal. Provide optional seal profiles that satisfy project requirements including movement and where required, utilize profile or cover plate that accepts pedestrian traffic.

2.2 Components and Materials

- A. Base Angle Steel Extrusions - Material to conform to properties of ASTM A 588. Extrusion shall be heavy duty and capable of accommodating various horizontal and vertical conditions and service load requirements. Provide extrusions as detailed on contract drawings. Utilize base angles for 3-1/2" and 4-1/2" system heights. Anchor using 3/8" by 3" long threaded concrete anchor spaced 18" o. c.

- B. Aluminum Side Rail Extrusions – Material to conform to properties of ASTM B 221, alloy 6063-T6.
1. Utilize low height aluminum side rail for 1-1/2" system height. Utilize 1/4" by 1-3/4" Tapcon concrete anchors spaced 18" o.c. for fastening low height aluminum side rail.
 2. Utilize low height aluminum side rail in conjunction with 1" height aluminum bar stock for 2-1/2" system height. Aluminum bar stock to be supplied factory welded to low height aluminum side rail. Utilize 1/4" by 2-1/4" concrete anchors spaced 18" o.c. to fasten to concrete.
 3. Utilize standard aluminum side rail for 3-1/2" and 4-1/2" system heights. Standard rail shall contain a recessed channel to receive base angle steel extrusion. Standard rail is fastened to base angle using 1/4" zinc nut and washer.

The top surface of both the low height and standard aluminum side rail shall contain two channels, one for receiving the elastomeric seal and the second for receiving the flashing sheet. Top surface shall contain screw race for fastening of the stainless steel retainer cap.

- C. Stainless Steel Retainer Cap – Material to conform to properties of ASTM A 167, Type 304 with 2B finish. Secure to aluminum side rails with 1/4" by 3/4" zinc plated sheet metal steel screws 12" o. c. Retainer cap shall be removable to access the elastomeric seal for repair and/or replacement.
- D. Elastomeric Seal - Material shall typically be a flexible, extruded Santoprene compound exhibiting the physical properties listed in the table below. Utilize manufacturer's alternate materials and seal profiles selected from their standard product offering to meet the requirements of product application. All seals shall incorporate a unique locking lug on the underside of seal that mechanically snaps into the aluminum side rail channel to ensure watertightness and proper joint performance. Gland shall have flanges that extend beyond locking lug and overlap the flashing sheet to provide for a watertight seal. Gland shall be secured in a compressed state through the use of a stainless steel retainer cap. Where required, provide manufacturer's seal profile that accepts pedestrian traffic.

The thermoplastic rubber seal element shall be sized to accommodate the total range of movement as dictated by the specifier at each joint location. Sizing shall be made in such a way as to ensure that the elastomeric membrane seal will remain under a degree of compression throughout the full movement cycle. The contractor will provide evidence utilizing manufacturer's product data that the membrane seal will comply with this requirement.

PHYSICAL PROPERTIES OF ELASTOMERIC SEAL

<u>PHYSICAL PROPERTIES</u>	<u>ASTM TEST METHOD</u>	<u>REQUIREMENT</u>
Shore A Hardness	D-2240	67 ± 3
Tensile Strength, min	D-412	850 psi
Ultimate Elongation, min	D-412	300%
100% Modulus	D-412	385 ± 95 psi
Ozone Resistance	D-1171	No Cracks
UV Resistance	SAE J1960	Pass
Staining Resistance	ASTM D925	No Staining
Tension set, average	D-412	10%

Tear strength, average	D-624	140 pli @ 73°F 58 pli @ 212°F
Compression Set, average, 168 hours	D-395	23% @ 73°F
Brittle point, average	D-746	< -76°F

E. Flashing sheet

Optional – Neoprene: Provide 0.062” thick by 12” width single ply fabric reinforced continuous Neoprene sheet in accordance with the following properties

Fabric Type:	4 ounce polyester cloth
Temperature Range:	-30F to +200F
Hardness Shore A	70 +/-5
Tensile, PSI	1000
Elongation, %	250

Tear, Die C, PPI 150

Optional – PVC: Provide 0.125” thick by 12” width single ply PVC sheet with a shore A hardness of 75 +/- 5.

Flashing sheet shall be sandwiched between two layers of the deck waterproofing system. Utilize stainless steel retainer cap to lock flashing sheet in place. Flashing sheet must have a short-term temperature resistance for incorporation with hot-applied deck waterproofing systems.

F. Cover Plate (if required) – Material to conform to properties of ASTM 5A 240 or ASTM A276, Type 316 Stainless Steel.

G. Fire Barrier Assembly (if required) - Designed for blockout condition only and for indicated or required dynamic structural movement without material degradation or fatigue. Tested in maximum joint width conditions with a field splice as a component of the expansion joint cover in accordance with ASTM E-119 at full rated period by a nationally recognized testing and inspecting organization. Supply Watson Bowman Acme ThermoShield or FlameGuard Fire Barrier as governed by joint opening and fire rating.

2.3 2.03 Fabrication

A. Thermoplastic Rubber Membrane Seal - Ship in the longest practical continuous length in manufacturer’s standard shipping carton or on wooden pallets shrink wrapped.

B. Joint Seal Directional Changes - At all horizontal changes in direction provide seals with factory heat welded splices such as 90° corners, tees and crosses. The seal shall extend a minimum of 2’-0” in each direction from the factory splice.

Only straight, butt splice connections shall be allowed on the jobsite following manufacturers written instructions utilizing specialty heat fusing equipment.

All factory and field fused connections shall incorporate bonding of the complete seal profile. This includes fusing of all internal and external web configurations.

- C. Base steel angle and aluminum extrusions to be shipped in manufacturer's standard lengths and shall be cut to exact length on jobsite where required. Extrusions shall be miter cut in the field to conform to directional changes unless otherwise contracted with expansion joint manufacturer to provide factory manufactured transitions.
- D. Elastomeric seals shall be shipped in the longest practical continuous length in manufacturer's standard shipping carton or on wooden pallets wrapped in plastic sheet good. Miter cut in the field to conform to directional changes unless otherwise contracted with expansion joint manufacturer to provide factory manufactured transitions.
- E. Fire Barriers (if required) - Ship manufacturer's standard assembly for the required hourly rating. Assemblies shall be miter cut in the field to accommodate changes in direction.

2.4 2.04 Finishes

- A. Stainless steel retainer cap shall be provided in standard 2B finish.
- B. B. Elastomeric seals shall be supplied in standard color offering: black.

PART 3 - EXECUTION

3.1 3.01 Installation

- A. Utilize a suitable high strength, high flow epoxy grout to level the expansion joint system on both sides of the expansion joint opening.
- B. Protect all expansion joint component parts from damage during placement of concrete, work in adjacent areas, construction traffic and thereafter until completion of structure.
- C. Expansion joint systems shall be set to the proper width for the ambient temperature at the time of installation. Properly align all steel base angles and aluminum side rails prior to anchoring to ensure proper joint performance and watertightness.
- D. Expansion joint systems shall be installed in strict accordance with the manufacturer's typical details and instructions along with the advice of their qualified representative. Contact manufacturer to discuss field splicing of all profiles and components prior to their installation to verify correct and proper procedures.

3.2 Clean and Protect

- A. Protect system and its components during construction. After work is complete in adjacent areas clean excess adhesive from elastomeric seal with a suitable cleaner that will not harm or attack material.

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END OF SECTION 07 95 00

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes
 - 1. Hollow metal doors and frames.
 - 2. The integration of a security system into the hollow metal door and frame work is required. The Contractor shall be responsible for the total and complete coordination of the security system components into the Work.

1.2 ACTION SUBMITTALS

- A. Product Data: Submit product data for each product indicated. Include material descriptions, core descriptions, label compliance, sound and fire-resistance ratings, and finishes for each type of door and frame specified.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Shop Drawings: Submit door and frame schedule using same reference designations indicated on Drawings. Include opening size(s), handing of doors, frame throat dimensions, details of each frame type, elevations of door design types, details of construction, location and installation requirements of door hardware and reinforcements, hardware group numbers, details of joints and connections, fire label requirements including fire rating time duration, maximum temperature rise requirements, and smoke label requirements.
 - 1. Indicate routing of electrical conduit and dimensions and locations of cutouts in doors and frames to accept electric hardware devices.

1.3 INFORMATIONAL SUBMITTALS

- A. Certificate of Compliance for Fire Rated Doors: Provide copies of Certificate of Compliance for all fire rated door assemblies, all smoke and draft control door assemblies, and all temperature rise rated door assemblies.

1.4 QUALITY ASSURANCE

- A. Hollow Metal Door and Frame Standard: Comply with the applicable provisions and recommendations of the following publications by Hollow Metal Manufacturers Association (HMMA) Div. of National Association of Architectural Metal Manufacturers (NAAMM), unless more stringent requirements are indicated in the Contract Documents:
 - 1. HMMA "Hollow Metal Manual."
 - 2. HMMA 861 "Guide Specifications for Commercial Hollow Metal Doors and Frames."
- B. Manufacturer Qualifications: A firm experienced in manufacturing hollow metal doors and frames 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.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver doors and frames palletted, wrapped, or crated to provide protection during transit and Project site storage.
- B. Inspect doors and frames, on delivery, for damage. Tool marks, rust, blemishes, and other damage on exposed surfaces will not be acceptable. Remove and replace damaged items as directed by Architect. Store doors and frames at building site in a dry location, off the ground, and in such a manner as to prevent deterioration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 or UL 10C "Standard for Positive Pressure Fire Tests of Door Assemblies." Fire classification labels at all doors with fire ratings greater than 20 minutes shall indicate the temperature rise developed on the unexposed surface of the door after the first 30 minutes of fire exposure.
 - 1. Provide metal labels permanently fastened on each door which is within the size limitations established by the labeling authority having jurisdiction.
- B. Smoke-Control Door Assemblies: Provide assemblies with gaskets 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.

- C. Thermally Rated Door Assemblies: Design, fabricate and install exterior door assemblies with the assembly U-factor maximum to comply with ASHRAE 90.1 and the IECC for the project specific geographic location of the building project when tested according to NFRC 100 (ASTM C 518).

2.2 MATERIALS

- A. Hot-Rolled Steel Sheets: ASTM A 1011/A 1011M, CS (commercial steel), Type B, free of scale, pitting, or surface defects; pickled and oiled. Not less than 16 gauge, thick where frames are indicated to be built into exterior walls, hot dip galvanize after fabrication in compliance with ASTM A 153/A 153M, Class B.
- B. Cold-Rolled Steel Sheets: ASTM A 1008/A 1008M, CS (commercial steel), Type B; free from scale, pitting, coil breaks, surface blemishes, buckles, waves, or other defects, exposed (matte) dull finish, suitable for exposed applications.
- C. Metallic-Coated Steel Sheets: ASTM A 653/A 653M, CS (commercial steel), Type B; with G60 zinc (galvanized) or A60 zinc-iron-alloy (galvannealed) coating, mill phosphatized.
- D. Inserts, Bolts, and Fasteners: Galvanized or cadmium plated steel.
1. Expansion Bolts and Shields: FS FF-S-325, Group III, Type 1 or 2.
 2. Machine Screws: FS FF-S-92, carbon steel, Type III cross recessed, design I or II recess, style 2C flat head.
- E. Filler: Sound deadening and heat retarding mineral fiber insulating material.
- F. Glass and Glazing: Refer to Section 08 80 00 "Glazing."
- G. Hardware: Refer to Section 08 71 00 "Door Hardware."

2.3 DOORS

- A. General: Provide flush-design doors, 1-3/4 inches thick, of seamless hollow construction, unless otherwise indicated. Construct doors with sheets joined at their vertical edges by continuous welding the full height of the door, or joined at vertical edges by 1 inch spot welds 6 inches on center, or intermittently welded seams. Voids between spot and intermediate welds shall be epoxy edge filled. Grind and finish all welds and edge fills flush to result in invisible seams on the door faces or vertical door edges.
1. For single-acting swing doors, bevel both vertical edges 1/8 inch in 2 inches.

- B. Interior Door Core Construction: Doors shall be stiffened by continuous vertically formed steel sections which, upon assembly, shall span the full thickness of the interior space between door faces. These stiffeners shall be 20 gauge minimum thickness, spaced so that the vertical interior webs shall be not more than 6 inches apart and spot welded to face sheets a maximum of 5 inches o.c. Place filler between stiffeners for full height of door.
- C. Exterior Door Core Construction: Subject to compliance with performance requirements, provide either polystyrene or polyurethane cores.
- D. Fire Door Cores: A continuous mineral fiberboard core permanently bonded to the inside face of the outer face sheet unless otherwise required to provide fire-protection and temperature-rise ratings indicated.
- E. Astragals: As required by NFPA 80 to provide fire ratings indicated.
- F. Top and Bottom Channels: Spot weld metal channel not less than thickness of face sheet to face sheets not more than 6 inches o.c.
 - 1. Reinforce tops and bottoms of doors with inverted horizontal channels of same material as face sheet so flanges of channels are even with bottom and top edges of face sheets.
 - 2. For exterior doors, close top edge with metallic-coated steel closing channel of same material, so webs of channels are flush with top door edges. Weld inverted steel channels to both face sheets or form integrally with edge construction of door.
- G. Hardware Reinforcement: Fabricate reinforcing from the same material as door to comply with the following. Offset reinforcement so that faces of mortised hardware items are flush with door surfaces.
 - 1. Hinges and Pivots: 7 gauge thick by 1-1/2 inches wide by 9 inches.
 - 2. Lock Front, Strike, and Flushbolt Reinforcements: 12 gauge thick by size as required by hardware manufacturer.
 - 3. Lock Reinforcement Units: 14 gauge thick by size as required by hardware manufacturer.
 - 4. Closer Reinforcements: 12 gauge thick one-piece channel by size as required by hardware manufacturer.
 - 5. Other Hardware Reinforcements: As required for adequate strength and anchorage.
 - 6. In lieu of reinforcement specified, hardware manufacturer's recommended reinforcing units may be used.
 - 7. Exit Device Reinforcements: 12 gauge thick by 10 inches high by 4 inches wide centered on exit device case body, unless otherwise recommended by exit device manufacturer.
- H. Electrical Requirements: Make provisions for installation of electrical items specified elsewhere; arrange so wiring can be readily removed and replaced.
 - 1. Provide all cutouts and reinforcements required for hollow metal doors to accept security system components.

2. Doors with Electric Hinges and Pivots: Provide with metal conduit or raceway to permit wiring from electric hinge or pivot to other electric door hardware.
 - a. Hinge Location: Center for doors less than 90 inches tall or second hinge from door bottom for doors greater than 90 inches; top or bottom electric hinge locations shall not be permitted.

I. Interior Hollow Metal Doors:

1. Extra Heavy Use Doors: Flush design with 14 gauge thick cold-rolled, stretcher-leveled steel face sheets and other metal components from hot- or cold-rolled steel sheets. Provide only where indicated.

J. Exterior Hollow Metal Doors: Flush design with [14 gauge16 gauge thick metallic-coated stretcher leveled steel face sheets, unless heavier gage is required to comply with the performance requirements, and other metal components from metallic coated steel sheets. Provide weep-hole openings in bottom of doors to permit entrapped moisture to escape.

2.4 WELDED FRAMES

- A. Fabricate hollow metal frames, formed to profiles indicated, with full 5/8 inch stops, and of the following minimum thicknesses.
 1. For exterior use, form frames from 14 gauge thick, metallic-coated steel sheets.
 2. For interior use, form frames from cold- rolled steel sheet of the following thicknesses:
 - a. Openings up to and Including 48 Inches Wide: 16 gauge.
 3. Frame heads at all masonry openings shall be formed to extend to the lowest CMU horizontal mortar joint.
- B. Provide frames either saw mitered and full (continuously) profile welded, or machine mitered and full profile welded, on back side at frame corners and stops with edges straight and true. Grind welds smooth and flush on exposed surfaces.
- C. Hardware Reinforcement: Fabricate reinforcements from same material as frame to comply with the following. Offset reinforcement so that faces of mortised hardware items are flush with surface of the frame.
 1. Hinges and Pivots: 7 gauge thick by 1-1/4 inches wide by 10 inches.
 2. Strike, Surface Mounted Hold Open Arms, and Flushbolt Reinforcements: 12 gauge thick by size as required by hardware manufacturer.
 3. Closer Reinforcements: 12 gauge thick one piece channel by size as required by hardware manufacturer.
 4. Other Hardware Reinforcements: As required for adequate strength and anchorage.

- D. Electrical Requirements: Make provisions for installation of electrical items specified elsewhere; arrange so wiring can be readily removed and replaced.
1. Provide all cutouts and reinforcements required for steel frames to accept security system components.
 2. Frames with Electric Hinges and Pivots: Provide welded on UL listed back boxes with metal conduit or raceway to permit wiring from electric hinge or pivot to other electric door hardware.
 - a. Hinge Location: Center for doors less than 90 inches tall or second hinge from door bottom for doors greater than 90 inches; top or bottom electric hinge locations shall not be permitted.
- E. Jamb Anchors: Locate jamb anchors above hinges and directly opposite on strike jamb as required to secure frames to adjacent construction. At metal stud partitions locate the additional jamb anchor below the top hinge.
1. Masonry Construction: Adjustable, corrugated or perforated, anchors to suit frame size; formed of same material and gauge thickness as frame; at non-rated frames use friction fit T-shaped anchors, at rated frames use anchors consisting of spot welded strap and adjustable anchor; with leg not less than 2 inches wide by 10 inches long. Unless closer spacing is required to meet the performance requirements furnish at least the number of anchors per jamb according to the following frame heights:
 - a. Two anchors per jamb up to 60 inches in height.
 - b. Three anchors per jamb from 60 to 90 inches in height.
 - c. Four anchors per jamb from 90 to 96 inches in height.
 - d. One additional anchor per jamb for each 24 inches or fraction thereof more than 96 inches in height.
 2. Metal-Stud Partitions: Metal channel stud zee anchor sized to match stud width, welded to back of frames, formed of same material and gauge thickness as frame. Unless closer spacing is required to meet the performance requirements provide at least the number of anchors for each jamb according to the following heights:
 - a. Three anchors per jamb up to 60 inches in height.
 - b. Four anchors per jamb from 60 to 90 inches in height.
 - c. Five anchors per jamb from 90 to 96 inches in height.
 - d. One additional anchor per jamb for each 24 inches or fraction thereof more than 96 inches in height.

3. In-Place Concrete or Masonry: Anchor frame jambs with minimum 3/8-inch- diameter countersunk flat head bolts into expansion shields or inserts 6 inches from top and bottom of each jamb with intermediate anchors spaced a maximum of 26 inches o.c. unless closer spacing is required to meet the performance requirements. Soffit face of frame shall be punched and dimpled to accept countersunk bolt head. Reinforce frame with spacer to prevent bowing. Bolt head shall be set slightly below soffit face, filled and ground smooth at time of installation.
- F. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, formed of same material as frame, 12 gauge thick, and punched with two holes to receive two 0.375 inch fasteners. Where floor fill or setting beds occur support frame by adjustable floor anchors bolted to the structural substrate. Terminate bottom of frames at finish floor surface. Weld floor anchors to frames with at least 4 spot welds per anchor.
- G. Head Strut Supports: Provide 3/8-by-2-inch vertical steel struts extending from top of frame at each jamb to supporting construction above. Bend top of struts to provide flush contact for securing to supporting construction above by bolting, welding, or other suitable anchorage. Provide adjustable wedged or bolted anchorage to frame jamb members to permit height adjustment during installation. Adapt jamb anchors at struts to permit adjustment.
- H. Head Reinforcement: For frames more than 48 inches wide in masonry wall openings, provide continuous steel channel or angle stiffener, 12 gauge thick for full width of opening, welded to back of frame at head. Head reinforcements shall not be used as a lintel or load-bearing member for masonry.
- I. Spreader Bars: Provide removable spreader bar across bottom of frames to serve as bracing during shipment and handling and to hold frames in proper position do not tack weld bars to frames.
- J. Door Silencer Holes: Drill strike jamb stop to receive three silencers on single door frames and for two silencers on double door frames. Insert plastic plugs in holes to keep holes clear during installation.
- K. Plaster, Mortar and Grout Guards and Removable Access Plates: Provide minimum 26 gauge thick guards or dust-cover boxes of same material as frame, welded to frame at back of hardware cutouts to close off interior of openings and prevent mortar or other materials from obstructing hardware and hardware fastener installation and hardware operation. Provide removable access plates in the heads of frames to receive overhead concealed door closers.

2.5 LOUVERS

- A. Door Louvers: Fabricate louvers and mount flush into doors without overlapping moldings on surface of door face sheets. Provide internal support as recommended by louver manufacturer. Prime paint steel louvers after fabrication.

1. Interior Louvers: Sightproof, stationary type, constructed of inverted V or Y-shaped blades formed of same material as door.
 - a. Steel: 18 gauge thick.
 2. Fire-Rated Automatic Louvers: Sightproof louver inserts fabricated from 16 gauge thick steel, spring operated, and released by 135 deg F fusible links listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by the same testing and inspecting agency that established fire-resistance rating of door assembly.
- B. Louvered Panels: Provide for installation in frames where indicated.
1. Interior Louvers: 18 gauge thick steel sheet. Fabricate units with stationary, sightproof, inverted V-shaped blades and U-shaped frames; not less than 1-3/8 inches thick. Space louver blades not more than 3 inches o.c. Assemble units by welding.

2.6 STOPS AND MOLDINGS

- A. Provide continuous stops and moldings around solid, glazed, and louvered panels where indicated.
- B. Form fixed stops and moldings integral with frame, on the exterior (non-secured) side of the frame.
- C. Provide removable stops and moldings formed of 20 gauge thick steel sheets matching hollow metal frames. Secure with countersunk oval head machine screws spaced uniformly not more than 12 inches o.c. Form corners with butted or mitered hairline joints.
- D. Coordinate rabbet width between fixed and removable stops with type of glass or panel and type of installation indicated.

2.7 FABRICATION

- A. Fabricate doors and frames rigid, neat in appearance, and free of defects, warp, wave, and buckle. Accurately form metal to sizes and profiles indicated. Accurately machine, file, and fit exposed connections with hairline joints. Weld exposed joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
- B. Hardware Preparation: Prepare doors and frames to receive hardware, including cutouts, reinforcement, mortising, drilling, and tapping, according to final hardware schedule and templates provided by hardware supplier. Secure reinforcement by spot welding. Comply with applicable requirements of ANSI/BHMA A156.115 and A156.115W specifications for door and frame preparation for hardware. Factory-reinforce doors and frames to receive surface-applied hardware. Factory drill and tap for surface-applied hardware, except at pushplates and kickplates provide reinforcing only.

1. Locate hardware as indicated on the Drawings or in Section 08 71 00 "Door Hardware" or, if not indicated, according to HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."
2. Exterior Hollow Metal Door Assemblies: Locate hardware in accordance with the applicable provisions of acceptance indicated under the door and frame manufacturer's Notice of Approval (NOA) as published by Miami-Dade County, Florida or Florida Product Approval as published by current Florida Building Code.

2.8 METALLIC-COATED STEEL FINISHES

- A. Surface Preparation: Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.
 1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
- B. Factory Priming for Field-Painted Finish: Apply shop primer immediately after surface preparation and pretreatment. Apply a sufficient number of coats, baked on, to obtain uniformly smooth exposed surfaces. Touch up surfaces having runs, smears, or bare spots.
 1. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free, primer complying with ANSI A250.10 acceptance criteria; recommended by primer manufacturer for zinc-coated steel; compatible with substrate and field-applied finish paint system indicated.

2.9 STEEL SHEET FINISHES

- A. General: Clean, treat and prime surfaces of fabricated steel door and frame work, inside and out, whether exposed or concealed in the construction.
- B. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning"; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale, shavings, filings, and rust, if present, complying with SSPC-SP 3, "Power Tool Cleaning."
- C. Factory Priming for Field-Painted Finish: Apply shop primer immediately after surface preparation and pretreatment. Apply a sufficient number of coats, baked on, to obtain uniformly smooth exposed surfaces. Touch up surfaces having runs, smears, or bare spots.
 1. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, corrosion-inhibiting, lead- and chromate-free, universal primer complying with ANSI A250.10 acceptance criteria; compatible with substrate and field-applied finish paint system indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install doors and frames according to the referenced standards, the Architect reviewed shop drawings, and manufacturer's written recommendations and installation instructions.
- B. Frames: Install frames where indicated. Extend frame anchorages below fills and finishes. Coordinate the installation of built-in anchors for wall and partition construction as required with other work.
 - 1. Welded Frames:
 - a. Set masonry anchorage devices where required for securing frames to in-place concrete or masonry construction.
 - 1) Set anchorage devices opposite each anchor location as specified and anchorage device manufacturer's written instructions. Leave drilled holes rough, not reamed, and free of dust and debris.
 - b. Placing Frames: Remove temporary spreader bars prior to installation of the frames. Set frames accurately in position; plumb; align, and brace securely until permanent anchors are set.
 - 1) At concrete or masonry construction, set frames and secure in place with machine screws and masonry anchorage devices. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 - 2) Anchor bottom of frames to floors through floor anchors with threaded fasteners.
 - 3) Field splice only at approved locations indicated on the shop drawings. Weld, grind, and finish as required to conceal evidence of splicing on exposed faces.
 - 4) Remove spreader bars only after frames are properly set and secured.
 - 2. At fire-rated openings, install frames according to NFPA 80.
- C. Doors:
 - 1. Fire-Rated Doors: Install with clearances as specified in NFPA 80.
 - 2. Smoke Control Doors: Install according to NFPA 105.

- D. Apply hardware in accordance with hardware manufacturer's instructions and Section 08 71 00 "Door Hardware." Drill and tap for machine screws as required. Do not use self tapping sheet metal screws. Adjust door installation to provide uniform clearance at head and jambs, and to contact stops uniformly. Adjust hardware items just prior to final inspection. Leave work in complete and proper operating condition.

3.2 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items just before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including doors or frames that are warped, bowed, or otherwise unacceptable.
- B. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.
 - 1. Finish Painting: Refer to Section 09 91 23 "Interior Painting" "
- C. Remove and replace defective work, including doors or frames that are warped, bowed, or otherwise defective.
- D. Institute protective measures required throughout the remainder of the construction period to ensure that the hollow metal doors and frames will be without damage or deterioration, at time of Substantial Completion.

END OF SECTION 08 11 13

SECTION 08 33 23 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following types of overhead coiling doors:

1. Service doors.
2. Fire-rated service doors.

1.2 ACTION SUBMITTALS

- A. Product Data: Submit product data for each product indicated.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Shop Drawings: Submit shop drawings including plans, elevations, sections, details of installation, wiring diagrams, and attachments to other Work.
1. Verify openings by field measurements before fabrication and indicate measurements on Shop Drawings.
- D. Samples: Submit samples for each exposed finish.

1.3 INFORMATIONAL SUBMITTALS

- A. Oversize Fire-Rated Construction Certification: Submit certifications for fire rated assemblies exceeding size limits of labeled assemblies, by testing agency acceptable to authorities having jurisdiction.

1.4 QUALITY ASSURANCE

- A. Fire-Rated Door Assemblies: Complying with NFPA 80, identical to assemblies tested per UL 10b, and labeled and listed for fire ratings indicated by UL, FM, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with construction requirements of tested and labeled fire-rated door assemblies, except for size.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Complying with NFPA 80; listed and labeled by qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252.
 - 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.
- B. Operational Life: Design components to operate for not less than 20,000 cycles and for 10 cycles per day.
 - 1. Operation Cycle: One complete cycle begins with door in closed position. Door is then moved to open position and back to closed position.
 - 2. Include tamperproof cycle counter.
- C. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. Component Importance Factor: 1.0.

2.2 DOOR CURTAIN AND CONSTRUCTION

- A. Door Curtain: Interlocking slats in continuous length for width of door. Unless otherwise indicated, slats of material thickness recommended by door manufacturer for performance, size, and type of door indicated.
 - 1. Steel Door Curtain Slats: Structural-quality, cold-rolled galvanized steel sheets, ASTM A 653/A 653M, with G90 zinc coating.
 - 2. Slat Type: Flat profile.
 - a. Inside Curtain Slat Face: Match material of outside metal curtain slat.
- B. Endlocks, General: Locate locks on every other curtain slat for curtain alignment and resistance against lateral movement.

1. Service Door Endlocks: Malleable-iron castings galvanized after fabrication, and secured to curtain slats with galvanized rivets, or high-strength nylon.
- C. Bottom Bar: Continuous channel or tubular shape, in material matching curtain slats.
 1. Astragal: Replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene that is cushion bumper for interior door.
 2. Motor-Operated Doors: With combination bottom astragal and sensor edge.
- D. Curtain Jamb Guides: Steel angles, or channels and angles, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading.
 1. Service Doors: Build up units with not less than 3/16 inch thick, galvanized steel sections complying with ASTM A 36/A 36M, and ASTM A 123. Slot bolt holes for guide adjustment. Prevent overtravel of curtain with removable stops on guides and hold windlocks with continuous bar.

2.3 HOODS AND ACCESSORIES

- A. Hood: Form to enclose coiled curtain and operating mechanism at opening head and act as weatherseal. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sag.
 1. Steel-Door Hoods: Fabricate from not less than 0.028 inch thick, hot-dip galvanized steel sheet that matches slat material.
 2. Fire-Rated Assemblies: Include automatic drop baffle to guard against passage of smoke or flame.
 3. Shape: Round.
- B. Smoke Seals: UL-listed and -tested, smoke-seal perimeter gaskets.
- C. Chain Lock Keeper: Suitable for padlock.
- D. Power-Operated Doors: With safety interlock switch to disengage power supply when door is locked.
- E. Fire-Rated Assemblies: With automatic-closing device inoperative during normal door operations, with governor unit complying with requirements in NFPA 80, with easily tested and reset release mechanism, and designed to be activated by the following:
 1. Governor: Oscillating type.
 2. Temperature rise and melting point of 165 deg F replaceable fusible links, interconnected and on both sides of wall of door opening.
 3. UL-labeled smoke detector and door-holder-release devices.

4. UL-labeled heat detector and door-holder-release devices.
 5. Building fire alarm and detection system and door-holder-release devices.
- F. Counterbalancing Mechanism: Adjustable, oil-tempered, heat-treated steel helical torsion springs mounted around structural carbon-steel pipe, and contained in barrel of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load; with grease-sealed bearings or self-lubricating graphite bearings.
1. Mounting Brackets: Cast-iron or cold-rolled steel plate with bell-mouth guide groove for curtain.
- G. Manual Door Operator: Chain hoist.
- H. Electric Door Operator: Type, size, and capacity recommended and provided by door manufacturer for door and operational life 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 door, disconnect device, emergency auxiliary operator, and accessories required for proper operation.
1. Comply with NFPA 70. Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency auxiliary operator.
 2. Electric Motors: Polyphase, medium-induction type with high-starting torque, reversible, continuous-duty, Class A insulated, electric motors, complying with NEMA MG 1; with overload protection, sized to start, accelerate, and operate door in either direction, from any position, at not less than 2/3 fps or more than 1 fps, without exceeding nameplate ratings or considering service factor. Coordinate wiring requirements and electric characteristics of motors with building electrical system.
 - a. Provide open dripproof-type motor, and controller with NEMA ICS 6, Type 1 enclosure.
 3. Control Equipment: NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc. Provide momentary-contact, three-button control station.
 - a. Interior Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
 4. Obstruction Detection Device: Provide each motorized door with self-monitoring, four-wire-configured-type, electrically actuated, external automatic safety sensor able to protect full width of door opening. Activation of sensor immediately stops and reverses downward door travel.
 5. Adjustable Limit Switches: Interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

2.4 FINISHES

- A. Galvanized-Steel Finish: Manufacturer's standard powder coating.
 - 1. Color and Gloss: Match sample .

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install door and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment supports.
 - 1. Fire-Rated Doors: Install to comply with NFPA 80.
- B. Lubricate bearings and sliding parts; adjust doors to operate easily, free from warp, twist, or distortion for entire perimeter.

3.2 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain doors. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 08 33 23

SECTION 08 41 13 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes aluminum-framed entrances and storefronts.
 - 1. Security system components may be incorporated into the door and frame openings of all aluminum-framed entrances and storefronts at the Owner's option. Cooperate with the Owner's security system contractors if the Owner chooses to incorporate security system components during the course of the Work.
 - 2. Single Subcontract Responsibilities: Refer to Section 08 44 13 "Glazed Aluminum Curtain Walls" for the requirements of single subcontract responsibilities for aluminum-framed entrances and storefronts.
- B. Section includes aluminum-framed entrances and storefronts. The aluminum-framed entrance and storefront work includes the following:
 - 1. Aluminum swing entrance doors and framing, including hardware, stripping and thresholds.
 - 2. Aluminum sliding entrance doors, and framing, including hardware, stripping and thresholds.
 - 3. Aluminum trim, flashings, and similar items in conjunction with aluminum-framed entrance and storefronts.
 - 4. Painting and coating in conjunction with the above aluminum items.
 - 5. Internal steel and aluminum reinforcements for aluminum-framed entrances and storefronts.
 - 6. Internal and perimeter sealing, joint fillers, weeps, vents and gasketing systems for aluminum-framed entrances and storefronts.
 - 7. Anchors, shims, fasteners, inserts, expansion devices, accessories, support brackets and attachments for aluminum-framed entrances and storefronts.
 - 8. Glass and glazing for aluminum-framed entrances and storefronts.
 - 9. Security system components may be incorporated into the door and frame openings of all aluminum-framed entrance and storefront work at the Owner's option. Cooperate with the Owner's security system contractors if the Owner chooses to incorporate security system components during the course of the Work.

1.2 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's specifications and installation instructions for each aluminum-framed entrance and storefront product specified.

- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Shop Drawings: Submit shop drawings showing scaled elevations, plans, and sections of the aluminum entrance and storefront work. Full-scale sections shall be prepared and submitted for details of the assemblies that cannot be shown in the elevations or sections. Include with shop drawings metal thickness of all metal components, glass thicknesses, metal finishes, location and installation requirements of door hardware and reinforcements, and all other pertinent information as necessary or requested by the Architect to indicate compliance with the Contract Documents. Details of field connections, anchorage, and their relationship to the work of others shall be clearly indicated for the coordination of the work by other building trades. Details of fastening and sealing methods and product joinery shall be shown to ensure proper performance of the field installation. No work shall be fabricated until shop drawings for that work have been approved by Architect for fabrication.
 - 1. Indicate routing of electrical conduit and dimensions and locations of cutouts in doors and frames to accept electric hardware devices.
 - 2. Show direction of coil coating applied to metal panel faces.
- D. Samples: Submit samples of the following before any work is fabricated:
 - 1. Three paired sets of samples for each exposed metal finish required. Sample finishes shall be on the specified alloy, temper, and thickness of metal required for the work. Where finishes involve color and texture variations, include sample sets showing the full range of variations expected. Furnish samples in either 12 inch lengths of patch fittings, rails, or 12 inch squares of sheet.

1.3 INFORMATIONAL SUBMITTALS

- A. Structural Calculations: Submit, for information only, copies of structural calculations indicating complete compliance with the specified performance requirements. Calculations shall be prepared, signed and sealed by a Professional Engineer registered in the state wherein the work is to be erected.
- B. Product Test Reports: Submit certified product test reports based on tests performed by an AAMA Accredited Laboratory clearly describing in written form, and in shop drawing form, compliance of each aluminum-framed entrance and storefront assembly (each swinging and sliding door) with requirements indicated based on comprehensive testing.
- C. Pre-Construction Sealant Compatibility and Adhesion Testing: Submit test results.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Instructions: Submit copies of an assembled and bound maintenance manual, describing the devices and procedures to be followed in cleaning, adjusting, and maintaining the aluminum-framed entrance and storefront work. Include information for maintaining operable doors, operating hardware, and replacing weather stripping.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Refer to Section 08 44 13 "Glazed Aluminum Curtain Walls."
- B. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Prior to the start of the aluminum-frame entrance and storefront work, and at the Contractor's direction, meet at the site and review the installation procedures and coordination with other work. Meeting shall include Contractor, Owner, Architect, aluminum-framed entrance and storefront installer, sealant installer, as well as any other subcontractors or material technical service representatives whose work, or products, must be coordinated with the aluminum-framed entrance and storefront work.

1.6 IDENTIFICATION, DELIVERY, STORAGE, AND HANDLING

- A. General: Refer to Section 08 44 13 "Glazed Aluminum Curtain Walls."
- B. Storage on Site:
 - 1. Store aluminum-framed entrance and storefront components in a location and in a manner to avoid damage to the components. Stacking shall be done in a way which will prevent bending, excessive pressure, abrasion or other permanent damage of the component and its finished surfaces.
 - 2. Store aluminum-framed entrance and storefront components and materials in a clean, dry location, away from uncured concrete, masonry work, sprayed on fireproofing work, and other construction activities. Cover with non-staining waterproof paper, tarpaulin, or polyethylene sheeting in a manner that will permit circulation of air inside the covering.
- C. Keep handling on site to a minimum. Exercise particular care to avoid damage to finishes of metals.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of supporting structure by field measurements before fabrication so that the entrance and storefront work will be accurately designed, fabricated and fitted to the structure. Indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work. Use Contractor's lines and benchmarks as a basis for measurements.
- B. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to, power supplies, fire alarm system and detection devices, access control system, security system, building control system.

1.8 WARRANTY

- A. General: Refer to Section 08 44 13 "Glazed Aluminum Curtain Walls."
- B. Special Warranty: Submit a 5 year written warranty, beginning from date of substantial completion, and executed by the Contractor, manufacturer and the aluminum-framed entrance and storefront installer agreeing to repair or replace components of entrance and storefront systems that develop defects in materials or workmanship within the specified warranty period. Defects include, structural failures, sealant failures, deterioration of metals, metal finishes, and other materials beyond normal weathering, failure of operating components to function properly, uncontrolled water leakage, uncontrolled air leakage, and any other evidence of failure or deterioration of the aluminum-framed entrance and storefront work to meet performance requirements.
- C. Warranty; Anodized Coatings: Submit a warranty for a period of 3 years, warranting that the anodized aluminum will not develop excessive fading or excessive non-uniformity of color or shade, and will not crack, peel, pit, or corrode; all within the limits defined as follows:
 - 1. "Excessive Fading" means a change in appearance which is perceptible and objectionable as determined by the Architect when viewed visually in comparison with the original color range samples.
 - 2. "Excessive Non-Uniformity" means non-uniform fading during the period of the warranty to the extent that adjacent panels have a color difference greater than the original acceptable range of color.
 - 3. "Will Not Pit or Otherwise Corrode" means there shall be no pitting or other type of corrosion discernable from a distance of 10 feet, resulting from the natural elements in the atmosphere at the Project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Manufacturer Qualifications:** The drawings and specifications are based on Kawneer 350T Insulpour Thermal Entrances and Kawneer 451T Trifab VG Framing System systems. . Award the fabrication of aluminum framed entrances and storefront components to a single firm specializing in the fabrication of aluminum framed entrances and storefront components who has successfully produced work similar in design and extent to that required for the project, in not less than three projects of similar scope to the satisfaction of the Architect, and whose work has resulted in construction with a record of successful in-service performance for a period of 5 years. The fabricator shall have sufficient production capacity, have organized quality control and testing procedures, and published written and illustrated installation manuals, to produce and properly install the aluminum framed entrances and storefront assemblies required without causing delay in progress of the Work. Other manufacturers capable of producing aluminum framed entrances and storefront systems meeting the performance requirements include the following:
- B. **Source Limitations:** Obtain aluminum framed entrances and storefronts from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. **General:** Refer to Section 08 44 13 "Glazed Aluminum Curtain Walls" for performance requirements, fabrication and erection standards; in addition provide the following:
 - 1. Design and fabricate aluminum-framed entrances to withstand the operating loads which result from heavy traffic conditions using the specified hardware, without measurable permanent deflection. Limit elastic deflections so as to provide the normal degree of rigidity required to avoid glass breakage, air leaks and other objectionable results of excessive flexibility. Provide weatherstripping at stiles, sill and head rails of door leaves, to minimize air, water and sound leaks.

2.3 MATERIALS

- A. **Aluminum:** Refer to Section 08 44 13 "Glazed Aluminum Curtain Walls."

- B. Aluminum: Conform to the requirements published in AA "Aluminum Standards and Data," referenced ASTM standards and the following. All aluminum extrusions shall be manufactured to dimensional tolerances so as to eliminate any edge projection or misalignment at joints. Unless otherwise specified, provide alloy and temper as required to suit performance requirements and finish(es) indicated. Provide concealed extruded bars, rods, shapes and tubes in alloys as recommended by the fabricator to join or reinforce assembly of exposed aluminum components.
1. Welding Rods and Bare Electrodes: AWS A5.10.
- C. Carbon Steel: For carbon steel components required to join, reinforce or support the assembly of aluminum components provide carbon steel conforming to ASTM A 36/A 36M for structural shapes, plates, and bars; ASTM A 1008/A 1008M for cold-rolled sheet and strip; or ASTM A 1011/A 1011M for hot-rolled sheet and strip.
1. Refer to Section 05 50 00, Metal Fabrications, for carbon steel framing, embedments, anchors, and welding that is not primary building structure nor furnished by the entrance and storefront fabricator but is required to transmit live and deadloads from the entrance and storefront framing to the primary building structure.
- D. Glass and Glazing Materials: As specified in Section 08 80 00 "Glazing."
- E. Anchors and Fasteners:
1. Material:
 - a. Wet Zones: Series 300 stainless steel.
 - b. Dry Zones: Carbon steel complying with either ASTM F 3125 or SAE Grade 5.
 2. Anchor and Fastener Metal Alloy Types, Designations and Standards: Alloys as selected by fabricator to prevent corrosion resistance with the components fastened. Do not use self-drilling, self-tapping type fasteners.
 3. Do not use exposed anchors and fasteners, except for hardware application. For hardware application, use countersunk Phillips flat-head machine screws finished to match framing members or hardware being fastened, unless otherwise indicated.
 4. Where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
- F. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123 or ASTM A 153 requirements.
- G. Concealed Flashing: Dead-soft, 0.018 inch thick stainless steel, complying with ASTM A 666, Type 304.
- H. Weather Stripping:

1. Compressible Weatherstripping: Compressible weatherstripping gaskets fabricated from extruded multi-fingered PVC, silicone or neoprene, replaceable, held in adjustable depth extruded metal strips to be mortised into edge of door panels for minimum exposure, metal finish to match finish of door.
2. Sliding Weather Stripping: Wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing complying with AAMA 701 requirements, replaceable, held in adjustable depth extruded metal strips to be mortised into edge of door panels for minimum exposure.

2.4 HARDWARE

- A. General: Provide hardware as specified in Section 08 71 00 Door Hardware. Finish exposed parts to match butt or pivot finish, unless otherwise indicated

2.5 SEALING MATERIALS

- A. Concealed Sealing Materials: All sealing materials concealed within the entrances and storefronts (i.e. glass pockets, end dams, fastener heads, and internal gutters) shall be silicone, compatible with and adherent to each material it will be in contact with, as recommended by the manufacturer to fulfill performance requirements.
 1. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Exposed Sealing Materials: All sealing materials exposed at entrance and storefront perimeter joints in contact with adjacent cladding materials: Silicone, refer to Section 07 92 00 "Joint Sealants."

2.6 FABRICATION

- A. General: Fabricate the entrances and storefronts to the designs, shapes, and sizes shown using the materials specified and shown to produce assemblies that meet or exceed the performance requirements. To the greatest extent possible, complete fabrication, assembly, finishing, hardware applications and other work before shipment to Project site.
 1. Door Stile and Rail Dimensions:
 - a. Bottomrails: Provide minimum 10 inch high one piece bottomrail unless otherwise indicated on the Drawings.
 - b. Stiles and Top Rail Dimensions: Medium stile; 3-1/2 inch nominal width.
 - c. Door Thickness: 1-3/4 inch.

- d. Preglaze door units to greatest extent possible, in coordination with installation and hardware requirements. Glazing, whether in factory or in field, shall be performed in accordance with Section 08 80 00 "Glazing."
 - e. Fabricate all doors and frames to accommodate the swing direction shown.
- 2. Provide extruded aluminum entrance door inserts at door frames designed with bosses sized to receive selected door gasket.
- B. Glazing Stops and Gaskets: Provide continuous interior glazing stops with concealed fasteners for all doors and frames. Provide stops with hairline joints at corners. Provide stops with beveled, not square, shouldered profile unless otherwise shown.
- C. Glass Components: Provide holes and cutouts in glass to receive hardware and accessories before tempering glass. Drill, countersink, and chamfer holes using tooling, materials and methods which are selected and applied to prevent spalling of the cut glass surfaces at holes and cutouts. The internal surface of holes and cutouts shall be smooth with minimal roughness from drilling operations. Do not cut, drill, or make other alterations to glass after tempering.
 - 1. Fully temper glass using horizontal (roller-hearth) process and fabricate so, when installed, roll-wave distortion is parallel with bottom edge of door or lite.
 - 2. Heat Soaking: After tempering, expose 100% of all fabricated glass units to European Standard EN14179 heat soaking process to reduce the potential for inclusion related glass breakage.
 - 3. Factory assemble components and factory install hardware to greatest extent possible.
- D. Metal Components: Doors and frames shall be cut, reinforced, drilled and tapped in strict accordance with the printed door hardware manufacturer's templates and instructions. Provide solid stainless steel hardware reinforcements, securely fastened to doors and frames where door hardware is to be attached.
 - 1. Security system components may be incorporated into the door and frame openings of all entrance doors and frames. Provide all cutouts required by the Owner's security system vendor and all prewiring for vendor provided security system devices. Wherever storefront and entrance framing components are to receive wiring provide unobstructed clear paths free of burrs and sharp objects with pull strings to facilitate wiring.
- E. Joints in Metal Work: All exposed work shall be carefully fitted and matched to produce continuity of line and design, with all joints, being accurately fitted for hairline contact and rigidly secured. Where additional rigidity or strength is required to satisfy the performance requirements reinforce entrance components with aluminum or carbon steel shapes, bars, and plates.
- F. Shop Assembly: As far as practicable, all fitting and assembly work shall be done in a fabrication shop.

1. For exterior entrances, provide weepholes and internal water passages in the glazing framing recesses as recommended by the respective glass and framing manufacturers to conduct infiltrating water to the exterior. Provide weep baffles secured to inside of frame behind weepholes.

G. Exposed Fasteners: Not permitted.

H. Protection of Metals: Wherever dissimilar metals are in contact, except in the case of aluminum in contact with galvanized steel, zinc, separate such surfaces with a coating of zinc rich primer, bituminous paint, or separation gaskets as the condition requires. Wherever aluminum comes in contact with concrete surfaces separate such surfaces with a coating of zinc rich primer, bituminous paint, or separation gaskets as the condition requires.

2.7 ALUMINUM FINISHES

A. General: As specified in Section 08 44 13 "Glazed Aluminum Curtain Walls."

2.8 COATINGS FOR CONCEALED METAL SURFACES

A. General: The following protective coatings shall be applied to surfaces of metals which are to be concealed in the construction:

1. Coating for Carbon Steel: Hot dip galvanized, complying with ASTM A 123.
2. Coating for Aluminum, Carbon Steel, and Bronze: Where aluminum or carbon steel surfaces are to be in contact with each other or in contact with dissimilar materials such as masonry or concrete, and where hot dip galvanizing of carbon steel is incompatible with component parts because of galvanic action or component fabrication tolerances provide one of the following:
 - a. Bituminous Paint: Cold-applied, non-sagging, bituminous paint complying with ASTM D 1187. Apply in two coats for an overall minimum dry film thickness of 25 mils.
 - b. Zinc Rich Primer: Organic zinc-rich primer, complying with SSPC-Paint 20.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate entrance and storefront work with the work of other Sections and provide items to be placed during the installation of other work at the proper time to avoid delays in the work.

- B. Templates and Diagrams: Furnish templates, diagrams, and other data to fabricators and installers of related work, as necessary for coordinating entrance and storefront installation.
- C. Place such items, including concealed overhead framing, accurately in relation to the final location of entrance and storefront components.

3.2 EXAMINATION

- A. Examine the substrates, adjoining construction, and conditions under which the Work is to be installed. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Before beginning installation of the entrance and storefront work examine all parts of the existing building structural frame and the existing building cladding indicated to support the entrance and storefront work. Ensure that the existing swing door thresholds, existing swing doors, swing door framing and subframes have been completely removed with all projecting anchors cut off flush. Notify Contractor in writing, of any dimensions, or conditions, found which will prevent the proper execution of the entrance and storefront work, including specified tolerances. Use Contractor's offset lines and bench marks as basis of measurements.

3.3 INSTALLATION

- A. General: Refer to Section 08 44 13 "Glazed Aluminum Curtain Walls."
- B. General: Comply with manufacturer's written instructions for protecting, handling, and installing entrance and storefront systems. Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight. Clean excess joint sealants from finished surfaces.
 - 1. Cut and trim component parts of the entrance and storefront work during erection only with the approval of the manufacturer or fabricator, and in accordance with his recommendations. Restore finish completely to protect material and remove all evidence of cutting and trimming. Remove and replace members where cutting and trimming has impaired strength or appearance, as directed by Architect.
 - 2. Set components within the erection tolerances with uniform joints. Place components on shims and fasten to supporting substrates using bolts and similar fasteners. Use stainless steel shims at structural connections only. U shaped shims at structural connections are not permitted. Use aluminum, stainless steel, or high impact polystyrene shims at other connections.
 - 3. Do not erect components that are warped, deformed, bowed, dented, defaced or otherwise damaged as to impair its strength or appearance. Remove and replace members damaged in the process of erection.

4. No holes or slots shall be burned, cut into, or field drilled in any building framing member without the written acceptance of the structural engineer.
 5. Install subsills in single piece lengths. Joints, where required, shall be placed at the maximum spacing allowed by the system manufacturer and sealed to result in a splice joint that is compliant with the manufacturers subsill splicing details. Fill anchor leg receptors at the splice joints as required by the system manufacturer. Spot heads of all fasteners with sealant.
 6. Attach and seal end dams at the ends of all subsills.
- C. Entrance and Storefront Framing: Install framing components plumb and true in alignment with established lines and grades without warp or rack of framing members.
- D. Entrance Doors: Doors shall be securely anchored in place to a straight, plumb and level condition, without distortion. Adjust doors to provide a tight fit at contact points for weathertight closure and to operate smoothly, without binding, with hardware functioning properly. Weatherstripping contact, and hardware movement, shall be field tested and final adjustment, and lubrication, made for proper operation and performance of doors.
1. Door Hardware: Refer to Section 08 71 00 "Door Hardware."
 2. Install surface-mounted hardware according to manufacturer's written instructions using concealed fasteners to greatest extent possible.
 3. Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.
 4. Set sill members in a bed of polyurethane sealant to provide weathertight construction. Comply with requirements of Section 07 92 00 "Joint Sealants."
- E. Install glazing to comply with requirements of Section 08 80 00 "Glazing," unless otherwise indicated.
- F. Install perimeter sealant to comply with requirements of Section 07 92 00 "Joint Sealants," unless otherwise indicated.
- G. Concealed Sealing Components: Apply sealant and gasket components that are integral to the entrance and storefront systems in strict accordance with the each component manufacturer's printed instructions. Before applying components remove all mortar, dust, dirt, moisture, and other foreign matter that will be deleterious to the intended performance of the component. Mask adjoining exposed surfaces to avoid spilling, dripping, dropping or other unintended contact of the sealing components onto adjacent exposed surfaces.

3.4 ERECTION TOLERANCES

- A. The entrance and storefront systems shall be fabricated and erected to accommodate the dimensional tolerances of the structural frame and surrounding cladding while providing the following as installed tolerances.

1. Variation from theoretical calculated position as located in plan or elevation in relation to established floors lines, column lines and other fixed elements of the structure, including variations from plumb, level, straight and member size: +/- 1/4 inch max in any 20'-0" run, column-to-column bay, or floor-to-floor height.
2. Alignment: Where surfaces abut in line, and where they meet at corners, limit offset from true alignment to 1/32 inch.
3. Variation from angle, or plumb, shown: +/- 1/8 inch max in any 10'-0" run or story height, non-cumulative.
4. Variation from slope, or level, shown: +/- 1/8 inch max in any 20'-0" run or column-to-column bay, non-cumulative.

3.5 ANCHORAGE

- A. Anchorage of the entrance and storefront work to the structure and surrounding cladding shall be in accordance with the accepted shop drawings.

3.6 WELDING

- A. Weld with electrodes and by methods recommended by manufacturer of material being welded, and in accordance with AWS D1.1 for concealed steel members.
- B. Welds and adjacent metal areas shall be thoroughly cleaned and coated with a single coat of bituminous paint.

3.7 REMOVAL OF DEBRIS

- A. All debris caused by, or incidental to, the erection of the entrance and storefront work shall be removed from the site and disposed of legally.

3.8 CLEANING

- A. Clean metal surfaces promptly after installation, exercising care to avoid damage to factory finished exposed surfaces.
- B. Wash glass on both faces not more than 4 days prior to date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer. Remove excess glazing and sealant compounds, dirt, and other substances.
- C. Immediately remove any deleterious material from surfaces of aluminum.

3.9 PROTECTION

- A. Institute protective measures required throughout the remainder of the construction period to ensure that entrance and storefront work will be without damage or deterioration, other than normal weathering, at time of acceptance.

END OF SECTION 08 41 13

SECTION 08 44 13 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes glazed aluminum curtain wall assemblies for the entire project. The aluminum curtain wall assemblies work includes the following:
1. Aluminum punched windows.
 2. Aluminum window wall, curtain wall and storefront framing.
 3. Swinging, balanced entrance doors and framing, including hardware, stripping and thresholds.
 4. Aluminum sliding entrance doors, and framing, including hardware, stripping and thresholds.
 5. Aluminum condensate guttersill extensions.
 6. Aluminum trim, snap in sealant stops, flashings and similar items in conjunction with aluminum curtain wall assemblies.
 7. Painting and coating in conjunction with the above aluminum items.
 8. Internal steel and aluminum reinforcements.
 9. Internal and perimeter sealing, joint fillers, weeps, vents and gasketing systems.
 10. Anchors, embedments, shims, fasteners, inserts, expansion devices, accessories, support brackets, attachments, and grout.
 11. Exterior wall insulation.
 12. Glass and glazing for the windows, window walls, curtain walls, entrances and storefronts.
 13. Window, window wall, curtain wall, entrance and storefront sample installations.
 14. Window, window wall, and curtain wall field testing.
 15. Security system components may be incorporated into the door and frame openings of all entrance work at the Owner's option. Cooperate with the Owner's security system contractors if the Owner chooses to incorporate security system components during the course of the Work.
- B. The Owner will engage an independent testing and inspection agency to verify the adequacy of the Contractor's quality control; refer to Section 01 40 00 "Quality Requirements." Before concealing the window, window wall and curtain wall work obtain the required inspections of same from a representative of the Owner's independent testing and inspection agency.

1.2 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's specifications and installation instructions for each glazed aluminum curtain wall component specified.

- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Shop Drawings: Submit shop drawings showing scaled elevations, plans, and sections of the glazed aluminum curtain wall work. Full scale sections shall be prepared and submitted for details of the assemblies that cannot be shown in the elevations or sections. Include with shop drawings metal thickness of all metal components, glass thicknesses, metal finishes, location and installation requirements of door hardware and reinforcements, and all other pertinent information as necessary or requested by the Architect to indicate compliance with the Contract Documents. Details of field connections, anchorage, and their relationship to the work of others shall be clearly indicated for the coordination of the work by other building trades. Details of fastening and sealing methods and product joinery shall be shown to ensure proper performance of the field installation. No work shall be fabricated until shop drawings for that work have been approved by Architect for fabrication.
- D. Samples: Submit samples of the following before any work is fabricated:
 - 1. Three paired sets of samples for each exposed metal finish required. Sample finishes shall be on the specified alloy, temper, and thickness of metal required for the work. Where finishes involve color and texture variations, include sample sets showing the full range of variations expected. Furnish samples in either 12 inch lengths of rails, or 12 inch squares of sheet.

1.3 INFORMATIONAL SUBMITTALS

- A. Structural Calculations: Submit, for information only, copies of structural calculations indicating complete compliance with the specified performance requirements. Calculations shall be prepared, signed and sealed by a Professional Engineer registered in the state wherein the work is to be erected. The Engineer shall be experienced in providing engineering services on a minimum of 3 projects for the type of curtain wall work indicated. The engineer shall provide evidence of their design methodology, analysis, including all assumptions.
- B. Field Test Reports: Submit field testing reports.
- C. Product Test Reports: Submit RECENT certified product test reports based on tests performed by an AAMA Accredited Laboratory clearly describing in written form, and in shop drawing form, compliance of each glazed aluminum curtain wall assembly (each window, window wall, curtain wall, entrance and storefront) with requirements indicated based on comprehensive testing.
- D. Preconstruction Sealant Compatibility and Adhesion Testing: Submit test results.
- E. Thermal Break Testing: Test results of structural and heat transmission values of the proposed thermal break construction are mandatory for thermally broken extrusion designs.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Instructions: Submit copies of an assembled and bound maintenance manual, describing the devices and procedures to be followed in cleaning, adjusting, and maintaining the curtain wall work. Include information for maintaining operable doors, operating hardware, and replacing weather stripping. Include structural silicone quality control plan for on-site reglazing of structural silicone glass units.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: The drawings and specifications are based on Basis of Design System listed in the Construction Drawings. Award the fabrication of glazed aluminum curtain wall components to a single firm specializing in the fabrication of glazed aluminum curtain wall components who has successfully produced work similar in design and extent to that required for the project, in not less than three projects of similar scope to the satisfaction of the Architect, and whose work has resulted in construction with a record of successful in-service performance for a period of 5 years. The fabricator shall have sufficient production capacity, have organized quality control and testing procedures, and published written and illustrated installation manuals, to produce and properly install the glazed aluminum curtain wall assemblies required without causing delay in progress of the Work.
 - 1. The manufacturer and installer may be one and the same entity.
 - 2. Implement a clear, project specific, system to track information flow and to check that the work is being engineered, and fabricated, to the most up to date revisions of the Contract Documents.
 - 3. Quality Control Plan: Submit a project specific quality control plan demonstrating how quality management will be implemented from award to final completion.
- B. Installer Qualifications: Subcontract the glazed aluminum curtain wall work to a firm which is specialized in the erection of curtain walls and who has successfully installed work similar in design and extent to that required for the Project, in not less than three projects of similar scope to the satisfaction of the Architect, and whose work has resulted in construction with a record of successful in-service performance for a period of 10 years.
 - 1. Implement a clear, project specific, system to track information flow and to check that the work is being engineered, fabricated, and installed to the most up to date revisions of the Contract Documents.
 - 2. Quality Control Plan: Implement a project specific quality control plan demonstrating how quality management will be implemented from award to final completion.
- C. Field Testing:

1. Field Testing: Test the curtain wall and punched opening window installations erected to the opaque portions of the exterior wall cladding in accordance with the specified field test methods. Conduct tests of each specified sample installation under the direction of the testing laboratory in the presence of the Owner, Architect, the Contractor, various component manufacturers and fabricators and the installer for each specified system incorporated in the sample installations.
 - a. Field Test for Water Leakage (Hose Stream Testing):
 - 1) Water Spray Test without Static Air Pressure Difference: AAMA 501.2.
 - 2) Correct all deficiencies observed as a result of this test and retest. For each unsuccessful field test, another similar sample installation area shall be selected and tested. Any repairs or remediation conducted to pass a test, if they constitute a change to the design (e.g., sealing of a joint that was previously open, or adding a weep hole) must be implemented throughout the work. Any remedial repairs which increase the maintenance requirements of the system (i.e., face sealing of a drained system), will not be accepted.
- D. Pre-Construction Sealant Compatibility and Adhesion Testing: Test results confirming compatibility and adhesion are mandatory for all concealed and exposed sealant materials in contact with exterior glazing, stone, precast, other sealants, flashings, metal framing, and shims prior to full size sample installation construction. Refer to Section 07 92 00 "Joint Sealants" for specific testing requirements, and anticipated lead-time necessary to perform testing.
- E. Standards: Comply with the applicable provisions and recommendations of the following standards below, where standards conflict the more stringent shall apply:
 1. Aluminum Association (AA):
 - a. "Aluminum Standards and Data", Latest Edition.
 - b. "The Aluminum Design Manual", Latest Edition.
 2. American Architectural Manufacturers Association (AAMA):
 - a. AAMA "Metal Curtain Wall Manual."
 - b. AAMA "Aluminum Curtain Wall Design Guide Manual," Volumes 1-9.
 - c. AAMA "Curtain Wall Manual #10."
 - d. AAMA "Aluminum Store Front and Entrance Design Guide Manual."
 - e. AAMA 501.1, "Specification for Method of Test for Metal Curtain Walls for Water Penetration Using Dynamic Pressure."
 - f. AAMA 501.2, "Specification for Field Check of Metal Curtain Walls for Water Leakage."
 - g. AAMA 501.4, "Recommended Static Testing Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Inter-story Drift."
 - h. AAMA 501.5, "Test Method for Thermal Cycling of Exterior Walls."

- i. AAMA 501.7, "Recommended Static Testing Method for Evaluating Windows, Window Wall, Curtain Wall and Storefront Systems Subjected to Vertical Inter-story Movements."
 - j. AAMA 503, "Field Testing of Metal Store Fronts, Curtain Walls and Sloped Glazing Systems."
 - k. AAMA 611, "Anodized Architectural Aluminum."
 - l. AAMA 612, "Voluntary Specifications, Performance Requirements, and Test Procedures for Combined Coatings of Anodic oxide and Transparent Organic Coatings on Architectural Aluminum."
 - m. AAMA 1801, "Acoustical Rating of Windows, Doors, and Glazed Wall Sections."
 - n. AAMA 2603, "Voluntary Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum."
 - o. AAMA 2604, "Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix)."
 - p. AAMA 2605, "Specification for Superior Performing Organic Coatings on Architectural Extrusions and Panels."
 - q. AAMA TIR-A8, "Structural Performance Poured and Debridged Framing Systems."
 - r. AAMA TIR-A9-2014 "Design Guide for Metal Cladding Fasteners."
 - s. AAMA QAG-1, Quality Assurance Processing & Monitoring Guide for Poured and Debridged Polyurethane Thermal Barriers."
 - t. AAMA QAG-2, Quality Assurance Processing & Monitoring Guide for Polyamide Thermal Barriers." •
- 3. American Institute of Steel Construction (AISC), "Steel Construction Manual," Current Edition.
 - 4. American Society for Testing and Materials (ASTM):
 - a. ASTM C 1401, "Standard Guide for Structural Sealant Glazing."
 - b. ASTM E 283, "Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences Across the Specimen."
 - c. ASTM E 330, "Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference."
 - d. ASTM E 331, "Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference."
 - e. ASTM E 488, Standard Test Methods for Strength of Anchors in Concrete Elements.
 - f. ASTM E 783, "Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors."
 - g. ASTM E 1105, "Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference."
 - h. ASTM E 1300, "Standard Practice for Determining Load Resistance of Glass in Buildings."

- i. ASTM E 1886, "Test Method for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials."
 5. American Society of Civil Engineers (ASCE), ASCE 7 Minimum Design Loads for Buildings and Other Structures.
 6. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), ASHRAE Fundamentals Handbook.
 7. National Association of Architectural Metal Manufacturers (NAAMM), "Metal Finishes Manual."
 8. Steel Structures Painting Council (SSPC): "Steel Structures Painting Manual, Vol. 2, Systems and Specifications."
 9. ANSI Z97.1 and Federal Standard 16 CFR 1201, Consumer Product Safety Commission (CPSC): "Safety Standard for Architectural Glazing Materials," as published in the Code of Federal Regulations (CFR). Comply with the applicable requirements of the laws, codes, ordinances and regulations of Federal and Municipal authorities having jurisdiction, wherever requirements conflict the more stringent shall be required. Obtain approvals from all such authorities. As a minimum provide safety glazing complying with ANSI Z97.1 for Category A performance and 16 CFR Part 1201 for Category II performance.
 10. Welding Standards: Welding shall be performed by skilled and qualified mechanics. Welding shall be performed in accordance with the applicable provisions of AWS D1.1 "Structural Welding Code - Steel" and AWS D1.2, "Structural Welding Code--Aluminum."
 11. Builders Hardware Manufacturers Association (BHMA):
 - a. ANSI/BHMA A156.10, "Power Operated Pedestrian Doors."
 - b. ANSI/BHMA A156.19, "Power Assist and Low Energy Power Operated Doors."
 12. Underwriters Laboratories (UL): Provide power door operators that comply with UL 325.
 13. National Fenestration Rating Council (NFRC):
 - a. NFRC 100, "Procedure for Determining Fenestration Product U-Factors."
 - b. NFRC 200, "Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence."
 - c. NFRC 300, "Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems."
- F. Sample Installations: After the construction and acceptance of testing mockup(s), construct sample installations of the final exterior wall assemblies where shown on the Drawings.
1. General: Sample installations will be used as a standard for judging acceptability of work for the Project. Replace unsatisfactory work as directed. Maintain sample installations during construction as a standard for judging acceptability of the exterior wall work. Properly finished, maintained, and performing sample installations shall be retained as a portion of the completed work.

2. Size: Provide full sized sample installations to the extent indicated on the Drawings, or if not indicated, as directed by the Architect. Sample installations shall be built on site complete with all glass, aluminum framing, adjacent cladding materials, anchors, connections, flashings, sealants, and joint fillers as accepted on the final shop drawings. Do not take special precautions or use techniques that do not represent those to be used on the work. Do not enclose the interior side of the wall with interior finishes and insulation materials.
- G. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Prior to the start of the curtain wall work, and at the Contractor's direction, meet at the site and review the construction schedule, availability of materials, installers personnel qualifications, equipment and facilities needed to make progress and avoid delays, installation procedures, testing, inspecting, and certification procedures, and coordination with other work. Meeting shall include Contractor, Owner, curtain wall installer, sealant installer, as well as any other subcontractors or material technical service representatives whose work, or products, must be coordinated with the curtain wall work.

1.6 IDENTIFICATION, DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with the applicable provisions of AAMA "Curtain Wall Manual #10" for the care and handling of curtain wall work from shop to site.
- B. All components of the curtain wall work shall be identified after fabrication by marks clearly indicating their location in the building. Packaging of components shall be so selected to protect the components from damage during shipping and handling.
- C. Storage on Site:
 1. Store curtain wall components in a location and in a manner to avoid damage to the components. Stacking shall be done in a way that will prevent bending, excessive pressure, abrasion or other permanent damage of the component and its finished surfaces.
 2. Store curtain wall components and materials in a clean, dry location, away from uncured concrete, masonry work, sprayed on fireproofing work, and other construction activities. Cover with non-staining waterproof paper, tarpaulin, or polyethylene sheeting in a manner that will permit circulation of air inside the covering.
- D. Keep handling on site to a minimum. Exercise particular care to avoid damage to finishes of metals.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of supporting structure by field measurements before fabrication so that the curtain wall work will be accurately designed, fabricated and fitted to the structure. Indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work. Use Contractor's lines and benchmarks as a basis for measurements.
- B. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to, power supplies, fire alarm system and detection devices, access control system, security system, building control system.

1.8 WARRANTY

- A. Special Warranty: Submit a 5 -year written warranty, beginning from date of substantial completion, and executed by the Contractor, manufacturer and the curtain wall installer agreeing to repair or replace components of curtain wall systems that develop defects in materials or workmanship, design and engineering, within the specified warranty period. Defects include, structural failures, sealant failures, deterioration of metals, metal finishes, and other materials beyond normal weathering, failure of operating components to function properly, uncontrolled water leakage, uncontrolled air leakage, and any other evidence of failure or deterioration of the curtain wall work to meet performance requirements.
- B. Warranty; Anodized Coatings: Submit a warranty for a period of 3 years, warranting that the anodized aluminum will not develop excessive fading or excessive non-uniformity of color or shade, and will not crack, peel, pit, or corrode; all within the limits defined as follows:
 - 1. "Excessive Fading" means a change in appearance which is perceptible and objectionable as determined by the Architect when viewed visually in comparison with the original color range samples.
 - 2. "Excessive Non-Uniformity" means non-uniform fading during the period of the warranty to the extent that adjacent panels have a color difference greater than the original acceptable range of color.
 - 3. "Will Not Pit or Otherwise Corrode" means there shall be no pitting or other type of corrosion discernible from a distance of 10 feet, resulting from the natural elements in the atmosphere at the project site.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Provide glazed aluminum curtain wall systems meeting or exceeding the following performance requirements:

GLAZED ALUMINUM CURTAIN WALLS

08 44 13 - 8

1. Structural Properties:

- a. Wind Loads: The glazed aluminum curtain wall work, including glass, shall be designed, fabricated and installed to withstand the maximum inward and outward wind pressures as required by IBC, ASCE 7, and as indicated on Drawings.
- b. Seismic Loads: As required by IBC, ASCE 7 and as indicated on Drawings.
 - 1) Provide miscellaneous steel framing not shown on drawings which is required to satisfy seismic criteria.
- c. Ice and Wind on Ice Loads: Calculated per ASCE 7 for ice sensitive elements as defined by ASCE 7. Calculations for ice and wind on ice loaded elements shall be made for strength only. Members supporting ice will not be required to be held to a specified deflection limit during ice related load events.
- d. Deflection Limitations:
 - 1) Deflections: Base calculations for the following deflections upon the combination of maximum design wind loads, building deflections, thermal stresses, and erection tolerances.
 - a) The deflection of the framing members for each unit of glass in a direction normal to the plane of the wall when subjected to the full code required wind loads indicated above shall not exceed 1/175 of the glass edge length or 3/4 inch whichever is less, except limit deflection of glass to 1 inch for exterior walls 1/2 inch for interior walls.
 - b) Deflection of Exterior Wall Louvers: $L/180$ of its clear span.
 - c) Glass, sealants and interior finishes shall not be included to contribute to framing member strength, stiffness or lateral stability.
 - d) Cantilever Deflection: The deflection of a framing member overhanging an anchor point shall be limited to $2L/175$ where L is the length of the cantilevered member.
 - e) Soffit framing shall be fabricated and installed to resist its own deadloads and upward and downward windloading with a deflection not to exceed 1/360 of the distance between supports.
 - f) The net deflection of metal wall panels in a direction normal to the plane of the wall when subjected to the maximum inward and outward wind pressures shall not exceed 1/60 of the panel's short length span. Deflection shall be measured relative to horizontal and vertical support members with allowable deflection determined by the lesser dimension.

- 2) Do not permit any permanent deformation (set) in the metal framing work. Permanent deformation, fastener, weld, or gasket failure, component breakage or disengagement shall not occur under wind loading equal to 1.5 times the wind loads (positive or negative). Permanent deformation shall be taken as deflection without recovery exceeding 1/1000 times span.
- e. Dead Loads:
- 1) Maximum full deadload deflections, parallel (in-plane) to wall plane, of framing members shall not reduce glass bite or glass coverage, to less than 75 percent of the design dimension, and shall not reduce edge clearance to less than 25 percent of design dimension or 1/8 inch whichever is greater.
 - 2) Limit deflections of metal members spanning door openings to 1/300. The clearance between the member and an operable door shall be no less than 1/16 inch.
 - 3) Twisting (rotation) of the horizontals due to the weight of the glass shall not exceed 1 degree, measured between ends and center of each span.
 - 4) Sills, Copings and Floor Closures: Capable of returning to original profile and position without permanent set after application of a 250 lb. concentrated live load. Deflection under load shall be not more than 1/16 inch.
- f. Uniform Structural Loads: Recent satisfactory uniform wind loading tests, acceptable to the Architect, of each glazed curtain wall assembly (each window, window wall, curtain wall, entrance and storefront) shall have been conducted in accordance with the requirements of ASTM E 330. Each assembly shall have been subjected to inward and outward acting uniform loads equal to 1.5 times the inward and outward acting design wind loads specified above under paragraph 'wind loads.' Satisfactory performance at these loads shall mean no glass or other component breakage, component disengagement, and no permanent deformation of main framing members in excess of the permanent deformation criteria specified above. The qualification of 'recent' test results is to limit the glazed curtain wall assemblies being provided for the project to only those which have been tested within the last seven years and under conditions similar to the project requirements.
- g. Operational (Traffic) Loads: Design and fabricate entrances to withstand the operating loads which result from heavy traffic conditions using the specified hardware, without measurable permanent deflection. Limit elastic deflections so as to provide the normal degree of rigidity required to avoid glass breakage, air leaks and other objectionable results of excessive flexibility. Provide weatherstripping at stiles, sill and head rails of door leaves, to minimize air, water and sound leaks.
- 1) Accommodate seismic movement as required by local code authorities to maintain exit doors in operable condition in case of seismic event.

- h. Exterior Snap Covers: Exterior snap covers having a 1" or more projection shall be mechanically fastened to resist loads from snow, ice, and window washing personnel and to avoid walking from thermal movement.

B. Air Leakage:

- 1. Typical Conditions: Air leakage through each glazed aluminum curtain wall assembly shall not have exceeded 0.06 cfm/sq. ft. of fixed wall area when tested in accordance with ASTM E 283 at a static-air-pressure difference of 6.24 lbf/sq. ft. Swinging Doors: Air leakage through each swinging entrance door shall not have exceeded 1.0 cfm/sq. ft. of surface area when tested in accordance with ASTM E 283 at a static-air-pressure difference of 1.57 lbf/sq. ft. with the door leaves in the closed position and the revolving door wings in the closed cross position.

C. Water Penetration:

- 1. Water penetration in this specification is defined as the appearance of uncontrolled water, other than condensation, on any indoor face of any part of the exterior wall that is not contained or drained back to the exterior, or that can cause damage to adjacent materials or finishes. Water contained within drained flashings, gutters, and sills is not considered water leakage. This definition of leakage of water replaces those contained under AAMA 501.1, paragraph 5.5 and ASTM E 331, paragraph 3.2.3.
- 2. Provision shall be made to drain to the exterior face of the wall any water entering the system.
- 3. No uncontrolled water penetration shall have occurred when each glazed aluminum curtain wall assembly (each fixed window, window wall, curtain wall, and storefront wall) was tested in accordance with the ASTM E 331 for one 15 minute cycle at a static pressure difference of 12 lbf/sq. ft. Minimum.

D. Thermal Movements: Fabricate the glazed aluminum curtain wall work to accommodate for such expansion and contraction of component materials, and supporting elements, as will be caused by surface temperatures ranging from -30 to +180 deg F, without causing noise, buckling, glass breakage, failure of joint sealants, undue stress on metal members and fasteners, failure of doors or other operating units to function properly, reduction of performance, and other detrimental effects.

- 1. Dimensions shown on Drawings are based on an assumed design temperature of +70 deg F. Fabrication and erection procedures shall take into account the ambient temperature range at the time of the respective operations.

E. Building Frame Movement: Design, fabricate and install glazed aluminum curtain walls to withstand building movements including thermal movements, loading deflections, shrinkage, creep and similar movements without glass breakage, anchor failures, or structural damage. Thermal movements shall be as specified above. Building frame deflections, shrinkage, creep and other movements are available from the structural engineer.

1. Comply with the pass/fail performance criteria of AAMA 501.4 for the project specific building occupancy type for building frame movements caused by seismic and wind induced inter-story drifting.
- F. Condensation Resistance: Design, fabricate and install the curtain wall systems to prevent excessive condensation on the indoor exposure of the wall with the mechanical system functioning under normal operating conditions. A computer-generated thermal analysis for each primary curtain wall system showing temperature gradients through each component of the glazed aluminum curtain wall and the location of the dewpoint shall be submitted with the shop drawing package. Excessive condensation is defined as water, ice, or frost on more than 5% of the interior or internal surface of any module or component of the wall or the accumulation of uncontrolled flow of water from condensation or melted frost on the wall at any location. An interior or internal surface of any module is any surface other than an exterior surface.
1. Outdoor: Ambient temperature of -5 deg F, 15 mph wind.
 2. Indoor: Ambient temperature of +70 deg F, relative humidity of 30 percent.
- G. Thermal Transmittance: Design, fabricate and install the aluminum framed curtain wall assemblies with the assembly U-factor maximum to comply with ASHRAE 90.1 and the IECC for the project specific geographic location of the building project when tested according to NFRC 100. A computer-generated thermal analysis (for each primary curtain wall system; showing temperature gradients through each component of the glazed aluminum curtain wall and the location of the dewpoint shall be submitted with the shop drawing package. Indoor humidity, and indoor and outdoor temperature parameters for the project are available from the mechanical engineer.
- H. Solar Heat-Gain Coefficient: Unless otherwise indicated in the glass schedules, provide glass for aluminum framed curtain wall assemblies with an assembly SHGC maximum to comply with ASHRAE 90.1 and the IECC for the project specific geographic location of the building project as determined according to NFRC 200 procedures.
- I. Glass Statistical Factor: Glass thicknesses when shown on the drawings, or specified, are for convenience of detailing only and are to be confirmed by the Contractor and/or glass manufacturer. All glass for the size openings shown will be provided in thicknesses such that the probability of breakage at the design "Wind Load" will not exceed 8 lights per 1000 lights (S.F. 2.5) based on a 3 second gust wind load duration, and reflectance and shading indicated. The glass manufacturer shall provide, on request, substantiating glass breakage data if such data is not otherwise available as manufacturer's published data.
1. The nominal glass thickness permitted shall be 6.0 mm.
 2. All exterior glass shall be assumed to be non-vented due to the use of interior sun screening devices such as shades and horizontal venetian blinds.

- J. Glazing System Design: Exterior wall interior glazing channel dimensions, shall be sized to provide bite on glass, minimum edge and face clearances, with reasonable tolerances, and to receive both dry gaskets, and recessed 2 and 4-side structural silicone beads that are below the sill, head, and jamb framing sight lines.
- K. Design Modifications:
 - 1. Submit design modifications necessary to meet the performance requirements and field coordination.
 - 2. Variations in details or materials shall not adversely affect the appearance, durability or strength of components, nor shall such variations cause excessive stress, or deflections, to the building structural frame.
 - 3. Maintain the general design concept without altering size of members, profiles and alignment.

2.2 MATERIALS

- A. Aluminum: Conform to the requirements published in AA "Aluminum Standards and Data", referenced ASTM standards and the following. All aluminum extrusions shall be manufactured to dimensional tolerances so as to eliminate edge projection or misalignment at joints. Unless otherwise specified, provide alloy and temper as required to suit performance requirements and finish(es) indicated. Provide concealed extruded bars, rods, shapes and tubes in alloys as recommended by the fabricator to join or reinforce assembly of exposed aluminum components.
 - 1. Alloys:
 - a. Sheet and Plate: Alloy 5005 and ASTM B 209, 'Anodizing Quality.'
 - b. Extruded Bars, Rods, Shapes, and Tubes: Alloy 6063 and ASTM B 221, 'Anodizing Quality.'
 - c. Bars, Rods, and Wire: ASTM B 211.
 - d. Sand Castings: ASTM B 26
 - e. Permanent Mold Castings: ASTM B 108.
 - 2. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
 - 3. Shapes and Thickness: Provide shapes as shown and as required to suit the performance requirements.
- B. Carbon Steel: For carbon steel components required to join, reinforce or support the assembly of aluminum components provide carbon steel conforming to ASTM A 36/A 36M for structural shapes, plates, and bars; ASTM A 1008/A 1008M for cold-rolled sheet and strip; or ASTM A 1011/A 1011M for hot-rolled sheet and strip; ASTM A 500 or ASTM A 501 for steel tubing.

1. Refer to Section 05 50 00, Metal Fabrications, for carbon steel framing, embedments, anchors, and welding that is not primary building structure nor furnished by the curtain wall fabricator but is required to transmit live and deadloads from the curtain wall to the primary building structure.
- C. Anchors and Fasteners: Fastener design for aluminum components shall be in accordance with the applicable provisions of the Aluminum Association Aluminum Design Manual AA-ADM1.
 1. Material:
 - a. Wet Zones: Series 300 stainless steel.
 - b. Dry Zones: Carbon steel complying with either ASTM F 3125 or SAE Grade 5.
 2. Anchor and Fastener Metal Alloy Types, Designations and Standards: Alloys as selected by fabricator to prevent corrosion resistance with the components fastened. Do not use self-drilling, self-tapping type fasteners.
 3. Where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
- D. Concealed Flashing: Dead-soft, 0.018 inch thick stainless steel, complying with ASTM A 666, Type 304.
- E. Door Hardware: Refer to Section 08 71 00 "Door Hardware."
- F. Aluminum Entrance Doors and Frames: Refer to Section 08 41 13 "Aluminum-Framed Entrances and Storefronts."

2.3 SEALING, GLASS AND GLAZING MATERIALS

- A. Concealed Sealing Materials: All sealing materials concealed within the glazed aluminum curtain walls (i.e. glass pockets, end dams, fastener heads, and internal gutters) shall be silicone, compatible with and adherent to each material it will be in contact with, as recommended by the manufacturer to fulfill performance requirements.
 1. Each concealed sealant shall be identified on the shop drawings.
 2. Splice details shall be designed using silicone. Splice details shall be designed to accommodate the anticipated movement of the joint.
 3. All internal sealants which come in contact with the exposed sealants shall be compatible with and adherent to the exposed sealant.
- B. Exposed Sealing Materials: All sealing materials exposed at glazed aluminum curtain wall perimeter joints in contact with adjacent cladding materials: Silicone, refer to Section 07 92 00 "Joint Sealants."
- C. Glass and Glazing Materials: Refer to Section 08 80 00 "Glazing."

2.4 OTHER GLAZED ALUMINUM CURTAIN WALL COMPONENTS

- A. Sheet Metal Partition Filler Panels: Form sheet metal filler panels from 0.05 inch thick aluminum sheet for closing ends of gypsum wallboard partitions. Produce flat, flush surfaces without cracking and grain separation at bends. Incorporate reveals, trim, and concealed anchorages for attachment to adjacent surfaces. Adhesively attach vinyl foam sealant tape to filler panel edges which abut adjacent surfaces to form a continuous seal. Use vinyl foam sealant tape material set onto edge of filler panel. Uncompressed tape thickness shall be sized to fit 3/4 inch wide joint indicated with an additional thickness as required to provide a minimum 15 percent foam compression. Laminate layers of tape as recommended by the manufacturer to provide a single tape thickness for the joint indicated. Fill interior of panel with sound deadening mineral fiber insulation permanently attached to inside panel faces.
1. Vinyl Foam Sealant Tape: Adhesive-backed, closed-cell, compressible, non-extruding, sound transmission reducing, vinyl foam tape strips with approximately 10 Shore 00 hardness that allow fastener penetration without foam displacement, 0.90-inch- thick, in width 1/2-inch- less than window mullion width. Subject to compliance with specified requirements, furnish and install products by the following, or approved equal:
 - a. Norseal V820 Series, Norseal V8229 Tape, Saint Gobain; black color.
- B. Thermal Break Construction: Fabricate curtain walls with an integrally concealed, poured in place, urethane thermal break, located between extrusions exposed to the exterior or contacting exterior finish materials and window members exposed on the interior or contacting interior finish materials, in a manner which eliminates direct metal to metal contact between exterior and interior metal components of the curtain wall assemblies. Provide thermal breaks of low thermal conductive materials, which satisfy the performance requirements. Urethane material for thermal breaks shall have been designed for window, window wall, and curtain wall construction and have been tested to demonstrate resistance to thermal conductance and condensation. Urethane materials shall be selected which have been in successful use for a minimum of 5 years. All thermal breaks shall be formed under typical plant conditions in extrusions designed for the project and tested to confirm that the product will meet or exceed the performance requirements.
- C. Slip and Separator Gaskets:
1. Bolted Slip Joints: Non-metallic, low friction material bearing temperature and moisture resistances and low abrasion properties as required to suit performance requirements.
 2. Non-Bolted Slip Joints: Non-corrosive, non-toxic impregnated felt, or butyl tape with a pressure sensitive adhesive on one surface that is formulated for proper adhesion to metals indicated; gasket shall bear temperature and moisture resistance properties as required to suit performance criteria; thickness and width as required.
- D. Baffle Material: Reticulated foam baffle material with a pore count (ppi) as required by assembly fabricator to suit performance requirements.

- E. Insulation: Foil-faced, slag-wool-/rock-wool-fiber rigid board insulation for curtain walls; refer to Section 07 21 00 "Thermal Insulation" for insulation to be used in glazed curtain wall assemblies.
- F. Firesafing and Firestopping: Unfaced mineral wool safing insulation topped with smoke stopping material, refer to Section 07 84 43 "Joint Firestopping" for firesafing and firestopping to be used in conjunction with glazed curtain wall assemblies.
- G. Snap In Sealant Stops: Provide rigid PVC sealant stops of profile and hardness as recommended by the window fabricator and fabricated to a cross sectional profile to interlock with aluminum extrusions at all window perimeters.
- H. Louvers: Refer to Section 08 90 00 "Metal Louvers."
- I. Floor Cover Plates: Thickness of floor cover plates to be 3/16 inch, profiles as indicated on the drawings, or if not indicated, as accepted by the Architect on the shop drawings.
- J. Windowsill Extensions: Thickness to match non-structural extrusions, profiles as indicated on the Drawings.

2.5 FABRICATION

- A. General: Fabricate the glazed aluminum curtain walls to the designs, shapes, and sizes shown using the materials specified and shown to produce assemblies that meet or exceed the performance requirements. To the greatest extent possible complete fabrication, assembly, finishing, hardware applications and other work before shipment to Project site.
- B. Joints in Metal Work: All exposed work shall be carefully fitted and matched to produce continuity of line and design, with all joints, being accurately fitted for hairline contact and rigidly secured. Where additional rigidity or strength is required to satisfy the performance, requirements reinforce curtain wall components with aluminum or carbon steel shapes, bars, and plates.
- C. Shop Assembly: As far as practicable, all fitting and assembly work shall be done in a fabrication shop.
 - 1. Framing members attaching curtain wall components to building supports shall provide for 3-way adjustment to accommodate fabrication and construction tolerances and allow for thermal and building movements.
 - 2. Provide vents, weepholes and internal water passages in the glazing framing recesses as recommended by the respective glass and framing manufacturers to conduct infiltrating water to the exterior, and to avoid condensation at glass spandrel unit air spaces. Provide weep baffles secured to inside of frame behind vents and weepholes.
 - 3. Provide flush endcaps for all mullion extension cap extrusions.

- D. Exposed Fasteners: Not permitted.
- E. Protection of Metals: Wherever dissimilar metals are in contact, except in the case of aluminum in contact with galvanized steel, zinc, separate such surfaces with a coating of zinc rich primer, bituminous paint, or separation gaskets as the condition requires. Wherever aluminum comes in contact with concrete surfaces separate such surfaces with a coating of zinc rich primer, bituminous paint, or separation gaskets as the condition requires.
- F. Welding: Complete the welding of exposed surfaces prior to finishing.
 - 1. All welding shall be in accordance with the recommendations of the AWS and shall be performed with electrodes and/or by methods recommended by suppliers of the metal being welded. Fabricate welded aluminum assemblies so that fraying surfaces are free rinsing and will not trap coating solutions.
 - 2. Welds behind finished surfaces shall be so performed as to eliminate distortion, and discoloration, on the finished side. Plug, puddle, and spot welding are not permitted. Provide low heat filled welds using a chill bar on finished side to eliminate dimpling, distortion, and/or discoloration on the finished side. If weld heads appear on the finished surface, the weld head shall be ground, and polished to match and blend with the finish on adjacent parent metal. Weld spatter and welding oxides on finished surfaces shall be removed immediately.
 - 3. At joints where welding cannot be performed use concealed stainless steel fasteners to join assembly.
- G. Shop Painting of Carbon Steel: Ungalvanized steel items shall be thoroughly cleaned of all loose scale, filings, dirt, and other foreign matter, in accordance with SSPC SP3 "Power Tool Clean," and painted with coating as specified for carbon steel surfaces.

2.6 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish Application:
 - 1. Apply anodized coatings to all exposed surfaces of glazed aluminum curtain wall components.
 - 2. Extent of Coating Types:
 - a. Anodic Coatings: Except for exposed surfaces of exterior (weathering side) snap on exterior caps, metal panels, column covers, and the exposed interior surfaces of the main entry lobby ground floor storefront, apply anodized coatings to all exposed interior surfaces of glazed aluminum curtain wall components.

3. Adhesion and Compatibility Testing: Test samples of aluminum coatings on aluminum will be required for compatibility and adhesion testing of all sealants proposed for use on framing components. Refer to Section 07 92 00 "Joint Sealants."
- C. Appearance of Finished Work: During production, maintain large size color range samples for use in comparing against production material. Variations in appearance of abutting or adjacent pieces are acceptable if they are within the range of approved samples. Noticeable variations in the same piece are not acceptable.
- D. Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.
- E. Class I, Color Anodic Finish: Complying with AA-M12C22A42/A44 for an Architectural Class I finish and the following:
 1. Metal Preparation and Pretreatment: Remove die markings prior to finishing operations. Perform this work in addition to the finish specified. Scratches, abrasions, dents and similar defects are unacceptable.
 2. Thickness: Minimum 0.7 mil, weighing not less than 27.0 mg per sq. in., minimum apparent density of 38 g per cubic in.
 3. Performance Criteria: Meets or exceeding AAMA 611.
 4. Color: Medium matte finished, integrally colored or electrolytically deposited color anodized. See Construction Drawings for color.
 5. Post Anodizing Finish (Sealing): Anodized finishes shall be fully sealed by the manufacturer or processor according to procedures recommended by the licensor of the process. Maximum weight loss shall be 2.6 mg/ sq. in.

2.7 COATINGS FOR CONCEALED METAL SURFACES

- A. General: The following protective coatings shall be applied to surfaces of metals which are to be concealed in the construction:
 1. Coating for Carbon Steel: Hot dip galvanized, complying with ASTM A 123.
 2. Coating for Aluminum, and Carbon Steel: Where aluminum or carbon steel surfaces are to be in contact with each other or in contact with dissimilar materials such as masonry or concrete, and where hot dip galvanizing of carbon steel is incompatible with component parts because of galvanic action or component fabrication tolerances provide one of the following:
 - a. Zinc Rich Primer: Organic zinc-rich primer, complying with SSPC-Paint 20.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate glazed aluminum curtain wall work with the work of other Sections and provide items to be placed during the installation of other work at the proper time to avoid delays in the work.
- B. Place such items, including concealed overhead framing, accurately in relation to the final location of glazed aluminum curtain wall components.

3.2 EXAMINATION

- A. Examine the substrates, adjoining construction, and conditions under which the Work is to be installed. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Before beginning installation of the glazed aluminum curtain wall work examine all parts of the existing building structural frame and the existing building cladding indicated to support the glazed aluminum curtain wall work. Notify Contractor in writing, of any dimensions, or conditions, found which will prevent the proper execution of the glazed aluminum curtain wall work, including specified tolerances. Use Contractor's offset lines and benchmarks as basis of measurements.

3.3 INSTALLATION

- A. General: Comply with manufacturer's written instructions for protecting, handling, and installing glazed aluminum curtain wall systems. Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure non-movement joints. Loose particles present or resulting from fabrication or field cutting and drilling shall be removed by blowing out joints with oil free compressed air, or by vacuuming joints. Remove protective coatings, oils from cutting and drilling operations, and residue on metallic surfaces with solvents that leave no residue. Do not allow solvent to air dry without wiping. Use only lint free towels for wiping of surfaces. Wipe metal surfaces with IPA (isopropyl alcohol) or xylene unless otherwise required by compatibility and adhesion testing results. Seal joints watertight. Clean excess joint sealants from finished surfaces.
 - 1. Cut and trim component parts of the glazed aluminum curtain wall work during erection only with the approval of the manufacturer or fabricator, and in accordance with his recommendations. Restore finish completely to protect material and remove all evidence of cutting and trimming. Remove and replace members where cutting and trimming has impaired strength or appearance, as directed by Architect.

2. Set components within the erection tolerances with uniform joints. Place components on shims and fasten to supporting substrates using bolts and similar fasteners. Use stainless steel shims at structural connections only. U-shaped shims at structural connections are not permitted. Use aluminum, stainless steel, or high impact polystyrene shims at other connections.
 3. Do not erect components that are warped, deformed, bowed, dented, defaced or otherwise damaged as to impair its strength or appearance. Remove and replace members damaged in the process of erection.
 4. No holes or slots shall be burned, cut into, or field drilled in any building framing member without the written acceptance of the structural engineer.
- B. Glazed Aluminum Curtain Wall, Entrance and Storefront Framing: Install framing components plumb and true in alignment with established lines and grades without warp or rack of framing members.
- C. Entrance Doors: Doors shall be securely anchored in place to a straight, plumb and level condition, without distortion. Adjust doors to provide a tight fit at contact points for weathertight closure and to operate smoothly, without binding, with hardware functioning properly. Weatherstripping contact, and hardware movement, shall be field tested and final adjustment, and lubrication, made for proper operation and performance of doors.
1. Door Hardware: Refer to Section 08 71 00 "Door Hardware."
 2. Install surface-mounted hardware according to manufacturer's written instructions using concealed fasteners to greatest extent possible.
 3. Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.
 4. Set sill members in a bed of silicone sealant to provide weathertight construction. Comply with requirements of Section 07 92 00 "Joint Sealants."
 5. Set automatic entrance door header assemblies, operating brackets, and guides level and true to location with anchorage for permanent support.
 6. Install complete automatic door operator system in accordance with door manufacturer's instructions including controls, control wiring, and power units.
 - a. Refer to Division 26 Sections for connection to electrical power distribution system.
- D. Sheet Metal Partition Filler Panels: Locate and place partition filler panels plumb, level, and in alignment with adjacent construction, with uniform reveals as shown. Provide concealed foam tapes and install as the installation progresses to make installations acoustically sealed and light tight. Do not penetrate window and curtain wall framing with any type of fastenings.
- E. Flashing: Install flashings fabricated from specified flashing material to the profiles shown. Flashings shall be furnished in single piece lengths. Laps and joints, where required, shall be lap seamed by a minimum of 4 inches with lap completely embedded in sealant. Mechanical fasteners shall be used where necessary to maintain contact of overlapping elements. Spot heads of all fasteners with sealant. Refer to Section 07 62 00 "Sheet Metal Flashing and Trim."

- F. Install glazing to comply with requirements of Section 08 80 00 "Glazing," unless otherwise indicated.
- G. Install perimeter sealant to comply with requirements of Section 07 92 00 "Joint Sealants," unless otherwise indicated.
- H. Concealed Sealing Components: Apply sealant and gasket components which are integral to the glazed aluminum curtain wall systems in strict accordance with each component manufacturer's printed instructions. Before applying components remove all mortar, dust, dirt, moisture, and other foreign matter that will be deleterious to the intended performance of the component. Mask adjoining exposed surfaces to avoid spilling, dripping, dropping or other unintended contact of the sealing components onto adjacent exposed surfaces.
- I. Field Applied Insulation:
 - 1. Exterior Wall Building Insulation: Install insulation materials as specified in Section 07 21 00 "Thermal Insulation."
 - 2. Firesafing: Clean debris from behind curtain wall framing during erection and provide temporary closures to prevent further accumulation of debris. Install firesafing to comply with local authorities having jurisdiction and AAMA TIR-A3 "Fire Resistive Design Guidelines for Curtain Wall Assemblies." Install firesafing with securely anchored metal flanges or make equivalent provisions to prevent dislocation. Comply with the requirements of Section 07 84 43 "Joint Firestopping."

3.4 ERECTION TOLERANCES

- A. The glazed aluminum curtain wall systems shall be fabricated and erected to accommodate the dimensional tolerances of the structural frame and surrounding cladding while providing the following as installed tolerances.
 - 1. Variation from theoretical calculated position as located in plan or elevation in relation to established floors lines, column lines and other fixed elements of the structure, including variations from plumb, level, straight and member size: +/- 1/4 inch max in any 20'-0" run, column-to-column bay, or floor-to-floor height.
 - 2. Alignment: Where surfaces abut in line, and meet at corners, limit offset from true alignment to 1/32 inch.
 - 3. Variation from angle, or plumb, shown: +/- 1/8-inch max in any 10'-0"run or story height, non-cumulative.
 - 4. Variation from slope, or level, shown: +/- 1/8-inch max in any 20'-0"run or column-to-column bay, non-cumulative.

3.5 ANCHORAGE

- A. Anchorage of the glazed aluminum curtain wall work to the structure shall be in accordance with the accepted shop drawings.

3.6 WELDING

- A. Weld with electrodes and by methods recommended by manufacturer of material being welded, and in accordance with AWS D1.1 for concealed steel members.
- B. Welds and adjacent metal areas shall be thoroughly cleaned and coated with a single coat of bituminous paint.

3.7 REMOVAL OF DEBRIS

- A. All debris caused by, or incidental to, the erection of the glazed aluminum curtain wall work shall be removed from the site and disposed of legally.

3.8 CLEANING

- A. Clean metal surfaces promptly after installation, exercising care to avoid damage to factory finished exposed surfaces.
- B. Wash glass on both faces not more than 4 days prior to date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer. Remove excess glazing and sealant compounds, dirt, and other substances.
- C. Immediately remove any deleterious material from surfaces of aluminum.

3.9 PROTECTION

- A. Institute protective measures required throughout the remainder of the construction period to ensure that glazed aluminum curtain wall work will be without damage or deterioration, other than normal weathering, at time of acceptance.

3.10 DEMONSTRATION

- A. Engage automatic entrance door manufacturer's installer to train Owner's maintenance personnel to adjust, operate, and maintain automatic entrance doors as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, complying with safety requirements, and maintaining equipment and schedules.
 2. Review data in maintenance manuals. Refer to Section 01 77 00 "Closeout Procedures."
 3. Review data in maintenance manuals. Refer to Section 01 78 23 "Operation and Maintenance Data."
- B. Schedule training with Owner with at least seven days' advance notice.

END OF SECTION 08 44 13

SECTION 08 63 00 - METAL-FRAMED SKYLIGHTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes metal-framed skylights.

1.2 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's specifications and installation instructions for each metal framed skylight component specified.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Shop Drawings: Submit shop drawings showing scaled elevations, plans, and sections of the metal framed skylight work. Full scale sections shall be prepared and submitted for details of the assemblies that cannot be shown in the elevations or sections. Include with shop drawings metal thickness of all metal components, glass thicknesses, metal finishes, and all other pertinent information as necessary or requested by the Architect to indicate compliance with the Contract Documents. Details of field connections, anchorage, and their relationship to the work of others shall be clearly indicated for the coordination of the work by other building trades. Details of fastening and sealing methods and product joinery shall be shown to ensure proper performance of the field installation. No work shall be fabricated until shop drawings for that work have been approved by Architect for fabrication.
- D. Samples: Submit samples of the following before any work is fabricated:
 - 1. Three paired sets of samples for each exposed metal finish required. Sample finishes shall be on the specified alloy, temper, and thickness of metal required for the work. Where finishes involve color and texture variations, include sample sets showing the full range of variations expected. Furnish samples in either 12 inch lengths of rails or 12 inch squares of sheet.
 - 2. Glass Samples:
 - a. Except for clear glass, submit samples of each glass type specified, in the form of 12 inch square Samples.
 - b. Submit samples of each glass type specified where production run variations and defects are expected.

1.3 INFORMATIONAL SUBMITTALS

- A. Structural Calculations: Submit, for information only, copies of structural calculations indicating complete compliance with the specified performance requirements. Calculations shall be prepared, signed and sealed by a Professional Engineer registered in the state wherein the Work is to be erected.
- B. Field Test Reports: Submit field testing reports.
- C. Product Test Reports: Submit RECENT certified product test reports based on tests performed by an AAMA Accredited Laboratory clearly describing in written form, and in shop drawing form, compliance of the metal framed skylight with requirements indicated based on comprehensive testing.
- D. Preconstruction Sealant Compatibility and Adhesion Testing: Submit test results.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Deliver in manufacturer's containers suitable for storing, clearly labeled as to type, size, and thickness. Include manufacturer's instructions for care and storage of glass. Store on the premises where directed.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Refer to Section 08 44 13 "Glazed Aluminum Curtain Walls."
- B. Single Subcontract Responsibility: The drawings and specifications are based on Basis of Design System listed in the Construction Drawings. Award the metal framed skylight work to a single firm specializing in the fabrication, and installation, of metal framed skylights who has successfully produced and installed work similar in design and extent to that required for the Project, in not less than three projects of similar scope to the satisfaction of the Architect, and whose work has resulted in construction with a record of successful in-service performance for a period of 10 years. The subcontractor shall have sufficient production capacity, have organized quality control and testing procedures, to produce and properly install the metal framed skylight work required without causing delay in progress of the Work.
- C. Field Testing: Test the metal framed skylight in accordance with the specified field test methods. Conduct tests under the direction of a qualified testing laboratory in the presence of the Owner, Architect, the Contractor, various component manufacturers and fabricators and the installer for each specified system incorporated in the sample installations.
 - 1. Field Test for Water Leakage:
 - a. Water Spray Test without Static Air Pressure Difference: AAMA 501.2.

- b. Correct all deficiencies observed as a result of this test and retest. Repairs or remediation conducted to pass a test, if they constitute a change to the design (e.g., sealing of a joint that was previously open, or adding a weep hole) must be implemented throughout the work. Remedial repairs which increase the maintenance requirements of the system (i.e., face sealing of a drained system), will not be accepted.
- D. Preconstruction Sealant Compatibility and Adhesion Testing: Test results confirming compatibility and adhesion are mandatory for all concealed and exposed sealant materials in contact with exterior glazing, stone, precast, other sealants, flashings, metal framing, and shims prior to full size sample installation construction. Refer to Section 07 92 00 "Joint Sealants" for specific testing requirements, and anticipated lead time necessary to perform testing.
- E. Standards: Comply with the applicable provisions and recommendations of the following standards below, where standards conflict the more stringent shall apply:
 - 1. Aluminum Association (AA):
 - a. No. 1 "Aluminum Standards and Data."
 - b. "The Aluminum Design Manual."
 - 2. American Architectural Manufacturers Association (AAMA):
 - a. AAMA 501.2, "Specification for Field Check of Metal Curtain Walls for Water Leakage."
 - b. AAMA 611, "Anodized Architectural Aluminum."
 - c. AAMA 2605, "Specification for Superior Performing Organic Coatings on Architectural Extrusions and Panels."
 - 3. American Institute of Steel Construction (AISC), "Steel Construction Manual," Current Edition.
 - 4. American Society for Testing and Materials (ASTM):
 - a. ASTM E 283, "Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences Across the Specimen."
 - b. ASTM E 330, "Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference."
 - c. ASTM E 331, "Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference."
 - d. ASTM E 1300, "Standard Practice for Determining Load Resistance of Glass in Buildings."
 - 5. National Association of Architectural Metal Manufacturers (NAAMM), "Metal Finishes Manual."
 - 6. Steel Structures Painting Council (SSPC): "Steel Structures Painting Manual, Vol. 2, Systems and Specifications."

7. ANSI Z97.1 and Federal Standard 16 CFR 1201, Consumer Product Safety Commission (CPSC): "Safety Standard for Architectural Glazing Materials," as published in the Code of Federal Regulations (CFR). Comply with the applicable requirements of the laws, codes, ordinances and regulations of Federal and Municipal authorities having jurisdiction, wherever requirements conflict the more stringent shall be required. Obtain approvals from all such authorities. As a minimum provide safety glazing complying with ANSI Z97.1 for Category A performance and 16 CFR Part 1201 for Category II performance.
 8. Welding Standards: Welding shall be performed by skilled and qualified mechanics. Welding shall be performed in accordance with the applicable provisions of AWS D1.1 "Structural Welding Code - Steel" and AWS D1.2, "Structural Welding Code--Aluminum."
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Prior to the start of the metal framed skylight work, and at the Contractor direction, meet at the site to review methods and procedures related to metal-framed skylights work including, but not limited to, the following:
1. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
 2. Review structural load limitations of the roof areas immediately adjacent the skylight opening(s).
 3. Review skylight curb structural requirements.
 4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 5. Review required testing procedures.
 6. Review weather and forecasted weather conditions and procedures for unfavorable conditions.
 7. Review protection of adjacent roof areas.
 8. Review preparation and other requirements for installing structural silicone sealant.

1.6 IDENTIFICATION, DELIVERY, STORAGE, AND HANDLING

- A. Storage on Site:
1. Store metal framed skylight components in a location and in a manner to avoid damage to the components. Stacking shall be done in a way that will prevent bending, excessive pressure, abrasion or other permanent damage of the component and its finished surfaces.
 2. Store metal framed skylight components and materials in a clean, dry location, away from uncured concrete and other construction activities. Cover with non-staining waterproof paper, tarpaulin, or polyethylene sheeting in a manner that will permit circulation of air inside the covering.
- B. Keep handling on site to a minimum. Exercise particular care to avoid damage to finishes of metals.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of supporting structure by field measurements before fabrication so that the metal framed skylight work will be accurately designed, fabricated and fitted to the structure. Indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work. Use Contractor's lines and benchmarks as a basis for measurements. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 WARRANTY

- A. Special Warranty: Submit a 10 year written warranty, beginning from date of substantial completion, and executed by the Contractor, manufacturer and the metal framed skylight installer agreeing to repair or replace components of the metal framed skylight work that develop defects in materials or workmanship within the specified warranty period. Defects include structural failures, sealant failures, deterioration of metals, metal finishes, and other materials beyond normal weathering, uncontrolled water leakage, uncontrolled air leakage, and any other evidence of failure or deterioration of the metal framed skylight work to meet performance requirements.
- B. Warranty, High Performance Organic Coatings: Submit a warranty for a period of 20 years, warranting the integrity of film and permanence of color of the high performance organic coatings for the following:
 - 1. Color fade not to exceed 5 delta E units (Hunter) as calculated in accordance with ASTM D 2244 on exposed surfaces cleaned with clean water and a soft cloth.
 - 2. Degree of chalking not to exceed rating No. 8 when measured in accordance with ASTM D 4214 on exposed unwashed surfaces.
 - 3. Will not crack, check or peel.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Provide metal framed skylights meeting or exceeding the following performance requirements:
 - 1. Structural Properties: The metal-framed skylight work shall be designed to resist the combination of wind loads, snow loads, glass and framing deadloads, and skylight maintenance equipment loads required.

- a. Wind Loads: The metal-framed skylight work, including glass, shall be designed, fabricated and installed to withstand the maximum upward and downward wind pressures as required by IBC, ASCE 7, and as indicated on Drawings.
- b. Snow Loads: As required by IBC, ASCE 7, and as indicated on Drawings.
- c. Seismic Loads: As required by IBC, ASCE 7, and as indicated on Drawings.
- d. Deflection Limitations:
 - 1) Deflections: Base calculations for the following deflections upon the combination of maximum direct wind loads, building deflections, thermal stresses, and erection tolerances.
 - a) The deflection of any framing member in a direction normal to the plane of the metal framed skylight when subjected to the full code required wind loads specified above shall not exceed 1/450 of its clear span or 3/4 inch whichever is less, except limit center point deflection of glass to 1/2 inch. Span is defined as the distance between anchor centerlines; for cantilevers, span is defined as the distance between anchor centerline and the end of the cantilever.
 - b) Glass, sealants and interior finishes shall not be included to contribute to framing member strength, stiffness or lateral stability.
 - 2) Do not permit any permanent deformation (set) in the metal framing work. Permanent deformation, fastener, weld, or gasket failure, component breakage or disengagement shall not occur under wind loading equal to 1.5 times the wind loads (positive or negative). Permanent deformation shall be taken as deflection without recovery exceeding 1/1000 times span.
- e. Dead Loads:
 - 1) Maximum full deadload deflections, parallel (in-plane) to metal framed skylight plane, of framing members shall not reduce glass bite or glass coverage, to less than 75 percent of the design dimension, and shall not reduce edge clearance to less than 25 percent of design dimension or 1/8 inchwhichever is greater.

- f. **Uniform Structural Loads:** Recent satisfactory uniform wind loading tests, acceptable to the Architect, of each metal-framed skylight shall have been conducted in accordance with the requirements of ASTM E 330. Each skylight assembly shall have been subjected to upward and downward acting uniform loads equal to 1.5 times the upward and downward acting design wind loads specified above under paragraph 'wind loads.' Satisfactory performance at these loads shall mean no glass or other component breakage, component disengagement, and no permanent deformation of main framing members in excess of the permanent deformation criteria specified above. The qualification of 'recent' test results is to limit the metal-framed skylight assemblies being provided for the Project to only those that have been tested within the last seven years and under conditions similar to the Project requirements.

B. Water Penetration:

1. Water penetration in this specification is defined as the appearance of uncontrolled water, other than condensation, on any indoor face of any part of the metal-framed skylight.
2. Provision shall be made to drain to the exterior face of the metal-framed skylight any water entering the system.
3. No uncontrolled water penetration shall have occurred when each metal-framed skylight was tested in accordance with the ASTM E 331 for one 15-minute cycle at a static pressure difference of 12 lbf/sq. ft. minimum.

C. Thermal Movement: Fabricate the metal framed skylight work to accommodate for such expansion and contraction of component materials, and supporting elements, as will be caused by surface temperatures ranging from -5 to +180 deg F, without causing noise, buckling, glass breakage, failure of joint sealants, undue stress on metal members and fasteners, reduction of performance, and other detrimental effects.

1. Dimensions shown on Drawings are based on an assumed design temperature of +70 deg F. Fabrication and erection procedures shall take into account the ambient temperature range at the time of the respective operations.

D. Building Frame Movement: Design, fabricate and install metal framed skylights to withstand building movements including thermal movements, loading deflections, shrinkage, creep and similar movements. Thermal movements shall be as specified above. Building frame deflections, shrinkage, creep and other movements are available from the structural engineer.

E. Glass Statistical Factor: Glass thicknesses when shown on the drawings, or specified, are for convenience of detailing only and are to be confirmed by the Contractor and/or glass manufacturer. All glass for the size openings shown will be provided in thicknesses such that the probability of breakage at the design "Wind Load" will not exceed 1 light per 1000 lights (S.F. 5.0) based on a 3 second gust wind load duration, and reflectance and shading indicated. The glass manufacturer shall provide, on request, substantiating glass breakage data if such data is not otherwise available as manufacturer's published data.

F. Design Modifications:

1. Submit design modifications necessary to meet the performance requirements and field coordination.
2. Variations in details or materials shall not adversely affect the appearance, durability or strength of components, nor shall such variations cause excessive stress, or deflections, to the building structural frame.
3. Maintain the general design concept without altering size of members, profiles and alignment.

2.2 METALS

- A. Aluminum: Conform to the requirements published in AA "Aluminum Standards and Data," referenced ASTM standards and the following. All aluminum extrusions shall be manufactured to dimensional tolerances so as to eliminate any edge projection or misalignment at joints. Unless otherwise specified, provide alloy and temper as required to suit performance requirements and finish(es) indicated. Provide concealed extruded bars, rods, shapes and tubes in alloys as recommended by the fabricator to join or reinforce assembly of exposed aluminum components.

1. Alloys:
 - a. Sheet and Plate: Alloy 5005 and ASTM B 209, 'Anodizing Quality.'
 - b. Extruded Bars, Rods, Shapes, and Tubes: Alloy 6063 and ASTM B 221, 'Anodizing Quality.'
 - c. Bars, Rods, and Wire: ASTM B 211.
 - d. Sand Castings: ASTM B 26
 - e. Permanent Mold Castings: ASTM B 108.
2. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
3. Shapes and Thickness: Provide shapes as shown and as required to suit the performance requirements but with wall thickness of not less than the following:
 - a. Minimum Wall Thickness for Tube and Rafter (Structural) Extrusions: 1/8 inch.
 - b. Minimum Wall Thickness for Non-Structural Extrusions: 1/16 inch.
 - c. Aluminum Curb Angles: Extruded aluminum, or formed plate, to sizes as required to suit conditions indicated and having a minimum thickness of 1/8 inch unless greater thicknesses are required to suit system performance requirements.

- B. Carbon Steel: For carbon steel components required to join, reinforce or support the assembly of aluminum components provide carbon steel conforming to ASTM A 36/A 36M for structural shapes, plates, and bars; ASTM A 1008/A 1008M for cold-rolled sheet and strip; or ASTM A 1011/A 1011M for hot-rolled sheet and strip.

- C. Anchors and Fasteners:

1. Material: Series 300 stainless steel.
 2. Anchor and Fastener Metal Alloy Types, Designations and Standards: Alloys as selected by fabricator to prevent corrosion resistance with the components fastened. Do not use self-drilling, self-tapping type fasteners.
 3. Where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
 4. Exposed portions of fasteners and accessories shall match the color of the metal framed skylight.
 5. Movement Joints: Provide slip-joint linings, spacers, and sleeves of material and type recommended by manufacturer.
- D. Concealed and Curb Flashings: Dead-soft, 0.018 inch thick stainless steel, complying with ASTM A 666, Type 304, 2D finish.

2.3 SEALING, GLASS AND GLAZING MATERIALS

- A. Concealed Sealing Materials: All sealing materials concealed within the skylight framing shall be silicone, compatible with and adherent to each material it will be in contact with, as recommended by the manufacturer to fulfill performance requirements.
- B. Exposed Sealing Materials: All sealing materials exposed at metal framed skylight perimeter joints in contact with adjacent cladding materials: silicone, refer to Section 07 92 00 "Joint Sealants."
- C. Glass and Glazing Materials: Refer to Section 08 80 00 "Glazing."

2.4 OTHER METAL FRAMED SKYLIGHT COMPONENTS

- A. Slip and Separator Gaskets:
1. Bolted Slip Joints: Non-metallic, low friction material bearing temperature and moisture resistances and low abrasion properties as required to suit performance requirements.
 2. Non-Bolted Slip Joints: Non-corrosive, non-toxic impregnated felt, or butyl tape with a pressure sensitive adhesive on one surface that is formulated for proper adhesion to metals indicated; gasket shall bear temperature and moisture resistance properties as required to suit performance criteria; thickness and width as required.
- B. Baffle Material: Reticulated foam baffle material with a pore count (ppi) as required by assembly fabricator to suit performance requirements.
- C. Insulation: Rigid mineral fiber type, refer to Section 07 21 00 "Thermal Insulation."

2.5 FABRICATION

- A. General: Fabricate the metal framed skylights to the designs, shapes, and sizes shown using the materials specified and shown to produce assemblies that meet or exceed the performance requirements. To the greatest extent possible complete fabrication, assembly, finishing, and other work before shipment to Project site.
- B. Joints in Metal Work: All exposed work shall be carefully fitted and matched to produce continuity of line and design, with all joints, being accurately fitted for hairline contact and rigidly secured. Where additional rigidity or strength is required to satisfy the performance requirements reinforce metal framed skylight components with aluminum or carbon steel shapes, bars, and plates.
- C. Fabricate components to drain water passing joints and to drain condensation and moisture occurring or migrating within skylight system to the exterior.
- D. Fabricate components to accommodate expansion, contraction, and field adjustment, and to provide for minimum clearance and shimming at skylight perimeter.
- E. Form shapes with sharp profiles, straight and free of defects or deformations, before finishing.
- F. Fit and assemble components to greatest extent practicable before finishing.
- G. Prepare components to receive anchor and connection devices and fasteners. Provide concealed connectors, attachments, and fasteners exposed to view from the exterior.
- H. Welding: Complete the welding of exposed surfaces prior to finishing.
 - 1. All welding shall be in accordance with the recommendations of the AWS and shall be performed with electrodes and/or by methods recommended by suppliers of the metal being welded. Fabricate welded aluminum assemblies so that fraying surfaces are free rinsing and will not trap coating solutions.
 - 2. Welds behind finished surfaces shall be so performed as to minimize distortion, and discoloration, on the finished side. Plug, puddle, and spot welding are not permitted. Provide low heat filled welds using a chill bar on finished side to eliminate dimpling, distortion, and/or discoloration on the finished side. If weld heads appear on the finished surface, the weld head shall be ground, and polished to match and blend with the finish on adjacent parent metal. Weld spatter and welding oxides on finished surfaces shall be removed immediately. All exposed welds shall be ground to a minimum of 100 grit finish.
 - 3. At joints where welding cannot be performed use concealed stainless steel fasteners to join assembly.
- I. Before shipping, shop assemble, mark, and disassemble components that cannot be permanently shop assembled.

- J. Provide continuous aluminum curb with weatherproof expansion joints and fully sealed corners. Locate weep holes in the curb at each rafter connection to drain condensation.
- K. Provide continuous stainless steel curb flashing with lap seamed and soldered joints and intersections.
- L. Provide continuous, pitched, stainless steel lined extruded aluminum gutters where indicated. Joints for stainless steel liners shall be lap seamed and soldered. Joints for aluminum gutters shall be silicone sealed. Provide thermal insulation at all lined gutters.
- M. Protection of Metals: Wherever dissimilar metals are in contact, except in the case of aluminum in contact with galvanized steel, zinc, separate such surfaces with a coating of zinc rich primer, bituminous paint, or separation gaskets as the condition requires. Wherever aluminum comes in contact with concrete surfaces separate such surfaces with a coating of zinc rich primer, bituminous paint, or separation gaskets as the condition requires.
- N. Shop Painting of Carbon Steel: Ungalvanized steel items shall be thoroughly cleaned of all loose scale, filings, dirt, and other foreign matter, in accordance with SSPC SP3 "Power Tool Clean," and painted with coating as specified for carbon steel surfaces.

2.6 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish Application:
 - 1. Apply high performance organic coatings to all exposed surfaces of metal framed skylight components.
 - 2. Adhesion and Compatibility Testing: Test samples of aluminum coatings on aluminum will be required for compatibility and adhesion testing of all sealants proposed for use on framing components. Refer to Section 07 92 00 "Joint Sealants."
- C. Appearance of Finished Work: During production, maintain large size color range samples for use in comparing against production material. Variations in appearance of abutting or adjacent pieces are acceptable if they are within the range of approved samples. Noticeable variations in the same piece are not acceptable.
- D. Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.
- E. High-Performance Organic Coating Finish: AA-C12C42R1x and the following:

1. Polyvinylidene fluoride finish coating containing not less than 70 percent of "ATO Atochem Kynar 500" or "Ausimont Hylar 5000" fluorocarbon resin specially formulated for spray application to extrusions and preformed aluminum metal shapes. Remove die markings, scratches, abrasions, dents and other blemishes before applying finish. Coating films shall be uniform and visibly free from flow lines, streaks, blisters, sags or other surface imperfections in the dry-film state on all surfaces.
 - a. Metal Preparation and Pretreatment: Pretreatment of aluminum surface and application of the finish shall be performed under specifications issued by the licensed formulator to approved applicator and the following as a minimum:
 - 1) The products used to form the chemical conversion coating on aluminum extrusions shall conform with ASTM D 1730, Type B, Method 5 (Amorphous Chromium Phosphate Treatment) or Method 7 (Amorphous Chromate Treatment), or Trivalent Chrome Treatment.
 - 2) The coating weight of the chemical conversion coating shall be a minimum of 40 mg. per sq. ft. on exposed surfaces as specified in ASTM B 449, Section 6, Class I. Processing shall conform with that specified in ASTM B 449, Section 5.
 - b. Thickness:
 - 1) Fluoropolymer 3-Coat Coating System: Minimum 1.6 mil total dry film thickness (0.25 mil primer +/- 0.05 mil and 1.35 mil topcoat).
 - c. Coating Performance Criteria: Meets or exceeding AAMA 2605.
 - d. Color: One custom color to be determined by Architect.
 - e. Manufacturer, Coating System:
 - 1) Three Coat, Opaque System; one of the following:
 - a) PPG Paints; Duranar XL.
 - b) Sherwin-Williams (formally Valspar, Inc.); Fluoropon Classic.
 - 2) Three Coat, Metal Flake System; one of the following:

2.7 COATINGS FOR CONCEALED METAL SURFACES

- A. General: The following protective coatings shall be applied to surfaces of metals which are to be concealed in the construction:
 1. Coating for Carbon Steel: Hot dip galvanized, complying with ASTM A 123.

2. Coating for Aluminum, and Carbon Steel: Where aluminum or carbon steel surfaces are to be in contact with each other or in contact with dissimilar materials such as masonry or concrete, and where hot dip galvanizing of carbon steel is incompatible with component parts because of galvanic action or component fabrication tolerances provide one of the following:
 - a. Bituminous Paint: Cold-applied, non-sagging, bituminous paint complying with ASTM D 1187. Apply in two coats for an overall minimum dry film thickness of 25 mils.
 - b. Zinc Rich Primer: Organic zinc-rich primer, complying with SSPC-Paint 20.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate metal framed skylight work with the work of other Sections and provide items to be placed during the installation of other work at the proper time to avoid delays in the work.
- B. A representative of the metal framed skylight manufacturer shall be present during the entire erection of the metal framed skylight work.

3.2 EXAMINATION

- A. Examine the substrates, adjoining construction, and conditions under which the Work is to be installed. Proceed with installation only after unsatisfactory conditions have been corrected.
 1. Before beginning installation of the metal framed skylight work examine all parts of the existing building structural frame, metal framed skylight structural framing, existing building cladding, and the existing parapet cladding indicated to support the metal framed skylight work. Notify Contractor in writing, of any dimensions, or conditions, found which will prevent the proper execution of the metal framed skylight work, including specified tolerances. Use Contractor's offset lines and bench marks as basis of measurements.

3.3 INSTALLATION

- A. General: Install all metal framed skylight components in strict accordance with the metal framed skylight manufacturer's instructions and the approved shop drawings to the slopes, lines, and levels shown. Comply with manufacturer's written instructions for protecting, handling, and installing metal framed skylight components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight. Clean excess joint sealants from finished surfaces.

1. Cut and trim component parts of the metal framed skylight work during erection only with the approval of the manufacturer or fabricator, and in accordance with his recommendations. Restore finish completely to protect material and remove all evidence of cutting and trimming. Remove and replace members where cutting and trimming has impaired strength or appearance, as directed by Architect.
 2. Set components within the erection tolerances with uniform joints. Place components on aluminum or stainless steel shims and securely and permanently anchor to supporting substrates using bolts and similar fasteners that permit adjustment for construction tolerances, irregularities, and alignment. Allow for structural movement and changes due to varying thermal conditions. Provide weeps in glazing recesses.
 3. Do not erect components that are warped, deformed, bowed, dented, defaced or otherwise damaged as to impair its strength or appearance. Remove and replace members damaged in the process of erection.
 4. Coat concealed surfaces of dissimilar materials, and any ferrous metal components, with a heavy coating of bituminous paint, zinc rich primer or other separation in accordance with manufacturer's recommendations. Where aluminum components will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
 5. No holes or slots shall be burned, cut into, or field drilled in any building framing member without the written acceptance of the structural engineer.
 6. Coordinate installation and connections of seals, insulation and flashings at metal framed skylight perimeters to maintain continuity of thermal and water barriers.
 7. Set continuous curbs and flashings in a full sealant bed, unless otherwise indicated. Comply with requirements in Section 07 92 00 "Joint Sealants."
- B. Metal Framed Skylight Maintenance Equipment: Install components to slopes and angles indicated and true in alignment with established lines and grades and in compliance with the Owner's performance criteria.
- C. Flashing: Install flashings fabricated from specified flashing material to the profiles shown. Flashings shall be furnished in single piece lengths. Laps and joints, where required, shall be lap seamed and soldered. Spot heads of all fasteners with sealant. Mechanical fasteners shall be used where necessary to maintain contact of overlapping elements.
- D. Glazing:
1. Cleaning: Clean stops, glazing channels, and rabbets that will be in contact with glazing materials. Remove protective coatings that might fail in adhesion or interfere with bond of sealants. Comply with manufacturer's instructions for final wiping of surfaces immediately before application of primers. Wipe metal surfaces with IPA (isopropyl alcohol) unless otherwise required by compatibility and adhesion testing results.
 - a. Prime surfaces to receive glazing compounds. When priming, comply with manufacturer's recommendations.

2. Inspect each piece of glass immediately before installation. Do not install any pieces that are improperly sized or have damaged edges, scratches or abrasion or other evidence of damage. Remove labels from glass immediately after installation.
3. Comply with the combined recommendations of the manufacturers of glass, sealants, gaskets, and other glazing materials, except where more stringent requirements are specified or shown, including those in referenced glazing publications.
 - a. Insulating glass units shall be installed in accordance with the insulated glass manufacturer's recommendations.
 - b. The installation of each light of exterior glass shall be watertight, airtight, and capable of withstanding temperature changes, wind loading, seismic loading, and snow loading without failure of any kind including loss or breakage of glass, failure of seal, exudation of sealant and excessive deterioration of glazing materials.
4. Glazing channel dimensions as indicated on the drawings provide necessary bite on glass, minimum edge and face clearances, with reasonable tolerances. Adjust as required by Project conditions during installation.
5. Protect glass from edge damage during handling and installation. Remove from Project site and legally dispose of glass units with edge damage or other imperfections of a kind that, when installed weaken glass and impairs performance and appearance.
6. Install elastomeric setting blocks in sill rabbets, sized and located to comply with insulating glass manufacturer recommendations. Place blocks to allow water passage to weep holes.
7. Install edge blocks, sized and located to comply with insulating glass manufacturer's recommendations.
8. Install glazing gaskets in accordance with manufacturer's instructions to provide a continuous watertight and airtight seal at corners and other locations where joints are required.
 - a. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lights.
 - b. Tightly butt glazing gaskets at corner joints and join with sealant recommended by the gasket manufacturer that will provide an airtight and watertight seal at joint.
9. Set glass lites with uniform pattern, draw, bow, and similar characteristics producing the greatest possible degree of uniformity in appearance.
 - a. Set insulating glass units with void between edge of units and glazing channel.
 - b. Orient and install insulating glass units made up with one light of low emissivity coated glass with the uncoated glass light on the inboard (building) side.

10. Supplement exterior dry glazing gaskets at the interface of snap on cap retainers and glass, and at snap on cap retainers and clamped perimeter flashings for water and air tightness with a continuous bead of weatherseal type wet glazing material. Promptly remove spilled, and excess, wet glazing materials from surfaces of glass and metal in accordance with glass and metal manufacturer's recommendations.
- E. Concealed Sealing Components: Apply sealant and gasket components that are integral to the metal framed skylight work in strict accordance with the each component manufacturer's printed instructions. Before applying components remove all mortar, dust, dirt, moisture, and other foreign matter that will be deleterious to the intended performance of the component. Mask adjoining exposed surfaces to avoid spilling, dripping, dropping or other unintended contact of the sealing components onto adjacent exposed surfaces.
- F. Insulation: Install insulation materials as specified in Section 07 21 00 "Thermal Insulation."

3.4 ERECTION TOLERANCES

- A. The metal framed skylights shall be fabricated and erected to accommodate the dimensional tolerances of the structural frame and surrounding cladding while providing the following as installed tolerances.
- B. Erection Tolerances: Install skylight components true in plane, accurately aligned, and without warp or rack. Adjust framing to comply with the following tolerances:
 1. Variation from theoretical calculated position as located in plan or elevation in relation to established floors lines, column lines and other fixed elements of the structure, including variations from plumb, level, straight and member size: +/- 1/4 inch max in any 20'-0" run, column-to-column bay, or floor to floor height.
 2. Alignment: Where surfaces abut in line, limit offset from true alignment to 1/32 inch. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.
 3. Variation from angle, or plumb, shown: +/- 1/8 inch max in any 10'-0"run or story height, non-cumulative.
 4. Variation from slope, or level, shown: +/- 1/8 inch max in any 20'-0"run or column-to-column bay, non-cumulative.

3.5 WELDING

- A. Weld with electrodes and by methods recommended by manufacturer of material being welded, and in accordance with AWS D1.1 for concealed steel members.
- B. Welds and adjacent metal areas shall be thoroughly cleaned and coated with a single coat of bituminous paint.

3.6 REMOVAL OF DEBRIS

- A. All debris caused by, or incidental to, the erection of the metal framed skylight work shall be removed from the site and disposed of legally.

3.7 CLEANING

- A. Clean the completed metal framed skylights, both metal and glazing material, on the top and bottom exposed surfaces, promptly after wet seals have cured, exercising care to avoid damage to glass, glazing, and factory finished exposed surfaces.
- B. Wash glass on both faces not more than 4 days prior to date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer. Remove excess glazing and sealant compounds, dirt, and other substances.
- C. Immediately remove any deleterious material from surfaces of aluminum.

3.8 PROTECTION

- A. Institute protective measures required throughout the remainder of the construction period to ensure that metal framed skylight work will be without damage or deterioration, other than normal weathering, at time of acceptance.

END OF SECTION 08 63 00

SECTION 08 71 00 - FINISH HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

Hardware for swinging, sliding, and folding doors except special types of unique and non-matching hardware specified in other sections.

1.02 RELATED WORK

- A. Division 8 – Hollow Metal Doors and Frames
- B. Division 8 – Flush Wood Doors
- C. Division 8 – Overhead Sectional Doors
- D. Division 8 – Metal Framed Storefronts
- E. Division 8 – Glass & Glazing
- F. Division 26 – Electrical
- F. Division 28 – Fire Alarm/Detection, Security Access

1.03 REFERENCES

- A. ADA - Americans with Disabilities Act of 1990 including Accessibility Guidelines as amended by the D.O.J. September 15, 2010, as adopted by the Authority Having Jurisdiction (AHJ).
- B. ANSI A117.1 - Buildings and Facilities - Providing Accessibility and Usability for Physically Handicapped People.
- C. ANSI/BHMA A156 (.1 through .21)
- D. ANSI/DHI – A115.1G Installation Guide for Doors and Hardware.
- E. FEMA P-361 – Safe Rooms for Tornadoes and Hurricanes.
- F. NFPA 80 - Fire Doors and Windows.
- G. NFPA 101 – Life Safety Code
- H. IBC - International Building Code, as adopted by public Authority Having Jurisdiction (AHJ).
- I. State and local Rules and Regulations for Barrier Free Facilities, as adopted by AHJ.

1.04 DOOR HARDWARE TYPES

- A. Types of finish hardware required include, but is not necessarily limited to, the following:
 - 1. Pivot sets and intermediate pivots.
 - 2. Hinges.
 - 3. Lock cylinders.
 - 4. Keys, keying, and key control.
 - 5. Locksets, latchsets, and privacy sets.
 - 6. Exit devices.
 - 7. Closers.
 - 8. Mullions.
 - 9. Overhead, wall, and floor stops.
 - 10. Protection plates.
 - 11. Gasketing for exterior and interior doors, as required.
 - 12. Door holders.

- 13. Door bottoms.
- 14. Thresholds.
- 15. Silencers.
- B. Requirements for design, grade, function, finish, size and other distinctive qualities of each type of door hardware is indicated elsewhere in this section or in the Door Hardware Schedule at the end of this section. Refer to Part 2 Products for Manufacturer's identification and allowable substitutions.

1.05 SUBMITTALS

- A. Under provisions of Division 1, submit the following:
 - 1. Product information: Manufacturer's published technical product data for all specified door hardware items indicating compliance with the requirements.
 - 2. Hardware Schedule:
 - a. Hardware schedules are intended for the Contractor's coordination of the work. Review and acceptance by the Architect or Owner does not relieve the Contractor of his exclusive responsibility to fulfill the requirements as shown and specified.
 - b. Submit hardware schedule in the manner and format as specified, complying with the actual construction progress schedule requirements for each draft. Include the following information:
 - 1) Explanation of all abbreviations, symbols, codes, at the like, including door handing.
 - 2) Type, style, function, size, and finish of each hardware item.
 - 3) Door and frame sizes and materials cross referenced to the Architect's marks in the door schedule.
 - 4) Room identification (name and number) on each side of door opening as indicated on the drawings.
 - 5) Product name, model number, description, and name of manufacturer of each item.
 - 6) Fastenings and other pertinent information.
 - 7) Locations of hardware cross referenced to architectural floor plans and door schedules.
 - 8) Mounting heights and locations of each type of hardware.
 - 3. Key Schedule:
 - a. Require a qualified representative of the hardware supplier to personally meet with the Owner and Architect to obtain the Owner's written key requirements.
 - b. Include a separate key schedule, showing clearly how the Owner's instructions on keying of locks has been fulfilled.
 - 4. Samples: Upon request, submit actual material samples of items indicated as for color selection.
 - 5. Templates: Hardware supplier will furnish hardware templates to the Contractor for each fabricator of doors, frames, and other work to be shop prepared or factory prepared for the installation of hardware. Upon request check shop drawings of such other work, to conform that adequate provisions are made for proper location and installation of hardware.
 - 6. Provide electrical operation technical sheets including product schematics, point to point diagrams, and electrical requirements of all electrified hardware. Completely coordinate with the general contractor, electrical engineer, electrician, security access

subcontractor and the installer. Operational descriptions are for demonstration only – verify operational intent with the owner, architect and electrical engineer.

- B. Under provisions of Division 1, submit the following:
1. Product information.
 2. Hardware schedule.
 3. Manufacturer's published operation and maintenance data. Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
 4. Tools and extra materials as required.
 5. Manufacturer's warranties, revise to meet criteria as established within this section. Warranty periods shall commence upon acceptance of the building by the owner. Where warranties listed exceed the manufacturer's standard warranty, obtain in writing an extended warranty to meet the requirements above and as noted. If the manufacturer will not meet these requirements, and another approved manufacturer will comply, supply the alternate approved manufacturer.

1.06 QUALITY ASSURANCE

- A. Acceptable Designs:
1. Items specified in this section are products which are of acceptable design.
 2. Do not substitute products without Architect's written prior approval per Section 01 60 00. Requests for approval shall be submitted by factory authorized distributor firms representing the products proposed for substitution. Items that are noted to allow no substitution are matching existing materials and the owner's material inventory for servicing the facility.
- B. Qualifications:
1. Manufacturer: Manufacturers named in Part 2 of this section with not less than 5 years experience in manufacturing commercial door hardware of the type indicated.
 2. Hardware Supplier:
 - a. A recognized architectural finish hardware supplier who has been furnishing hardware in the same state as the project for a period of not less than 5 years.
 - b. Hardware supplier's organization shall include an experienced Architectural Hardware Consultant (AHC), certified by the Door and Hardware Institute (DHI), who is physically available, at reasonable times during the course of the work, for consultation about project's hardware requirements, to Owner, Architect and Contractor. Mail or telephone correspondence is not acceptable.
 - c. Hardware supplier shall have local warehousing facilities and shall maintain an adequate parts inventory of items supplied for future service to the owner. Supplier will be a factory authorized distributor of all hardware specified.
 3. Installer: Company specializing in installing work of this section with not less than 5 years experience and acceptable to the manufacturers and the hardware supplier. Maintain regular work force of qualified personnel, trained, skilled, and experienced in installing door hardware and constant, competent supervision per the requirements of the General Contractor. The hardware installer shall meet with the representatives of the General Contractor and hardware supplier to jointly inventory all hardware items. Upon satisfactory inventory of products, the hardware installer accepts responsibility for all hardware items inventoried.
- C. Regulatory and Operational Requirements:

1. Provide hardware for all openings, whether specified or not, in compliance with NFPA Standard No. 80, proper operation and local building code requirements. Where required, provide only hardware which has been tested and listed by UL or FM for types and sizes of doors required and complies with requirements of door and door frame labels. Label hardware, as required, for compliance with pressure testing criteria as dictated in IBC.
2. Provide hardware which meets or exceeds handicap accessibility per local building code requirements. Conform to the Americans with Disabilities Act (ADA) of 1990 as amended by the D.O.J. September 15, 2010, as adopted by the Authority Having Jurisdiction (AHJ).

1.07 DELIVERY, STORAGE, HANDLING, AND PROTECTION

- A. Deliver, store, handle, and protect products to project site under provisions of Section 01600 and as specified herein.
- B. Require hardware supplier to:
 1. Tag each item or package separately, with identification related to final hardware schedule.
 2. Include manufacturer's basic installation instructions with each item or package.
 3. As material is received by hardware supplier from various manufacturers, sort and repackage in containers with each item clearly marked with appropriate opening numbers to match the approved hardware schedule. Two or more identical items may be packed in the same container.
 4. Deliver individually packaged hardware items at the proper times to the proper locations (shop or project site) for installation.
 5. Inventory hardware jointly with representatives of the General Contractor, hardware supplier and the hardware installer until each is satisfied that count is correct. Refer to paragraph 1.6-B-3.
- C. Protect hardware from theft by cataloging and storing in a secure and lockable area. Control the handling and installation of hardware items which are not immediately replaceable, so that the completion of the work will not be delayed by hardware losses, both before and after installation. Replace lost, missing, damaged, or stolen door hardware items at no additional cost to the Owner as required to meet schedule requirements.

1.08 SEQUENCING AND SCHEDULING

- A. Coordinate work of this section with the work of other sections of work under provisions of Division 1
- B. Furnish hardware templates to each fabricator of doors, frames, and other work to be shop or factory prepared for the installation of hardware.
- C. Verify completeness and suitability of door hardware with the hardware supplier and the hardware installer.

1.09 MAINTENANCE MATERIALS

- A. Under provisions of Division 1, furnish to Owner a complete set of special wrenches and tools applicable to each different or special hardware component as needed for Owner's continued adjustment, maintenance, removal, and replacement of door hardware.

- B. Special tools and accessories shall be supplied by the hardware component manufacturer.

PART 2 PRODUCTS

2.01 MATERIALS AND FABRICATION

- A. General:
1. Provide all door hardware for complete work, in accordance with the drawings and as specified herein.
 2. Quantities listed, in any instance, are for the Contractor's convenience only and are not guaranteed.
 3. Provide items and quantities not specifically mentioned to ensure a proper and complete operational installation. Match the quality and finish of items specified.
 4. Provide miscellaneous hardware as listed in hardware groups.
- B. Hand of door: Drawings show direction of slide, swing or hand of each door leaf. Door schedule indicates door and frame sizes, materials, required fire ratings, and other pertinent information. Furnish each item of hardware for proper installation and operation of door movement as indicated.
- C. Manufacturer's Name Plate: Do not use manufacturer's products which have manufacturer's name or trade name displayed in a visible location (omit removable name plates), except in conjunction with required UL or FM labels and as otherwise acceptable to the Architect. Manufacturer's identification will be permitted on rim of lock cylinders and latch faceplates only.
- D. Base Metals: Produce hardware units of basic metal and forming method indicated, using manufacturer's standard metal alloy, composition, temper and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units by applicable ANSI A156 series standard for each type hardware item and with ANSI A156.18 for finish designations indicated. Do not furnish "optional" materials or forming methods for those indicated, except as otherwise specified.
- E. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware which has been prepared for self tapping sheet metal screws, except as specifically indicated.
1. Screws: Furnish screws for installation, with each hardware item. Provide Phillips flat head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finishes of such other work as closely as possible, including "prepared for paint" in surfaces to receive painted finish.
 2. Concealed Fasteners: Provide concealed fasteners for hardware units which are exposed when door is closed, except to extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work, except where it is not feasible to adequately reinforce the work. In such cases, provide sleeves for each thru-bolt or use sex screw fasteners.

2.02 HINGES

- A. Manufacturer:
1. Listed in Door Hardware Schedule: Stanley

- 2. Approved Substitutions: Hager, Bommer
- B. Templates: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template produced units.
- C. Screws: Furnish Phillips flat head or machine screws for installation of units, except furnish Phillips flat head or wood screws for installation of units into wood. Finish screw heads to match surface of hinges.
- D. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - 1. Steel Hinges: Steel pins.
 - 2. Non-ferrous Hinges: Stainless steel pins.
 - 3. Exterior doors: Non-removable pins.
 - 4. Reverse bevel interior doors (lockable): Non-removable pins.
 - 5. Interior doors: Non-rising pins.
- E. Pin Tips: Flat button and matching plug, finished to match leaves.
- F. Number of Hinges: Provide number of hinges indicated, but not less than 3 hinges per door leaf for doors 90" or less in height and one additional hinge for each 30" of additional height.
- G. Butt type hinges and continuous hinges are to be warranted for a period of two years. Pivots shall be warranted for a period of two years.

2.03 LOCK CYLINDERS

- A. Manufacturer:
 - 1. Listed in Door Hardware Schedule: Dorma
 - 2. Substitutions: Russwin, Corbin
- B. Equip locks with 6-pin cylinders for standard keyed cylinders, Russwin D1 6-pin system, with construction keying for use during the construction phases.
- C. Construct lock cylinder parts from brass/bronze, stainless steel, or nickel silver.

2.04 KEYS, KEYING, AND KEY CONTROL

- A. Keys:
 - 1. Material: Provide keys of nickel silver only.
 - 2. Quantities: These quantities are to establish a maximum allowable quantity of cut keys to service the project and may not necessarily be assigned as noted. A lesser quantity of cut keys required will not result in any credits, nor a quantity of uncut keys to be issued unless noted otherwise.
 - a. 3 change keys per each cylinder unit.
 - b. 5 master keys per master.
 - c. 20 construction keys.
 - 3. Deliver keys to the Owner's representative: Send masterkeys to Owner via U.S. registered mail direct from hardware supplier.
- B. Keying:
 - 1. Comply with Owner's written instructions for masterkeying and, except as otherwise indicated, provide individual change keys for each lock which is not designated to be keyed alike with a group of related locks. Keying is to be provided by the owner as an extension of the existing masterkey system.
 - 2. Grandmaster key all cylinder items to coordinate with the Owner's instructions and existing Russwin D1 6-pin masterkey system. Permanently inscribe each key with the notation "DO NOT DUPLICATE".

C. Key Control:

1. Provide a key control system including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by the system manufacturer, with capacity for 150% of the number of locks required for the project.
2. Provide a hinged panel type cabinet, for wall mounting, Telkee AWC-150S or equal.
3. Provide cylinder units with concealed key control and keys with visual key control.

2.05 LOCKSETS, LATCHSETS, AND PRIVACY SETS:

A. Manufacturer:

1. Listed in Door Hardware Schedule: Dorma M9000 Series
2. Approved Substitutions: Best 45H, Schlage L9000

B. Types: Locksets, latchsets, and privacy sets as indicated in Door Hardware Schedule.

C. Strikes: Provide manufacturer's standard wrought box strike for each latch or lock bolt. Provide dust-proof strikes for foot bolts, except where not available. At these locations, provide manufacturer's standard recessed strike. Provide roller type strikes where recommended by lock, latch or bolt manufacturer. If aluminum frames are specified, confirm with the aluminum frame supplier that the standard lock strikes will function. Provide the manufacturer's standard extended lip strikes if required. Strikes may be provided by the prefinished metal frame manufacturer.

D. Lock Throw: Provide 3/4" minimum throw of mortise type latches and deadbolts used. Cylindrical latches will be 1/2" minimum. Comply with UL requirements for throw of bolts and latch bolts on rated fire openings.

E. Locks and latches shall be warranted for a period of five years.

2.06 EXIT DEVICES AND MULLIONS

A. Manufacturer:

1. Listed in Door Hardware Schedule: Dorma 9000
2. Substitutions: Precision 2000, Von Duprin 98

B. Provide risers, as needed, to prevent interference with door glazing kits.

C. Provide spacers as needed for proper application of removable mullions on narrow stop type frames.

D. Provide architecturally finished products.

E. Mullions shall be provided primed to be painted to match finish hardware.

F. Exit devices and related hardware shall be warranted for a period of five years.

2.07 CLOSERS:

A. Manufacturer:

1. Listed in Door Hardware Schedule: Best HD7016 Series
2. Approved Substitutions: Dorma 8616 Series, LCN 4040XP

B. Size of Units: Except as otherwise specifically indicated, comply with the manufacturer's recommendations for size of door control unit, depending on the size of the door, exposure to weather and anticipated frequency of use.

C. Provide manufacturer's standard through bolt attachment where door construction is not adequate for support.

- D. Arms:
 - 1. Provide parallel arms for all overhead closers, except as otherwise indicated. Provide drop plates as needed to prevent glazing interference.
- E. Mount all closers to the maximum allowable degree of opening by the closer manufacturer's template. Where closer arms incorporate dead stop features, mount closers to the maximum degree of opening available before conflict with adjacent structures. If not apparent on the contract documents, verify the use of open space with the Architect or Owner's Representative to determine the maximum allowable degree of opening.
- F. Access Free Manual Closers: Where manual closers are indicated for doors required to be accessible to the physically handicapped, provide adjustable units complying with ANSI A117.1 provisions for door opening force. Fire protection has precedence over handicap compatibility, check with local jurisdiction.
- G. Door closers and related hardware shall be warranted for a minimum period of twenty-five years. Electronic closers shall be warranted for a period of two years.

2.08 AUTOMATIC OPERATORS

- A. Manufacturers:
 - 1. Listed in Door Hardware Schedule: Dorma
 - 2. Approved Substitutions: LCN, Stanley
- B. Provide units which conform to the requirements of the Americans with Disabilities Act of 1990 (ADA) and as required by local jurisdiction.
- C. At fire rated openings, provide units which are listed by Underwriter's Laboratories (UL) for use on such openings.
- D. Automatic operators shall be warranted for a period of two years.

2.09 WALL AND FLOOR STOPS

- A. Manufacturers:
 - 1. Listed in Door Hardware Schedule: Trimco
 - 2. Approved Substitutions: Rockwood, Hiawatha, Don-Jo
- B. General: Except as otherwise indicated, provide stops (wall, floor or overhead) at each leaf of every swinging door leaf.

2.10 OVERHEAD STOPS

- A. Manufacturer:
 - 1. Listed in Door Hardware Schedule: ABH
 - 2. Approved Substitutions: Rixson, Glynn Johnson
- B. Mount stops to the maximum degree of opening available before conflict with adjacent structures, or, if adjacent structures are not considered, to the maximum allowable by stop manufacturer's template.
- C. If not apparent on the contract documents, verify the use of open space with the Architect or Owner's Representative to determine the maximum allowable degree of opening.
- D. Overhead stops in exterior doors must be manufactured from stainless steel, US32D finish.
- E. Overhead stops shall be warranted for a period of two years.

2.11 PROTECTION PLATES

- A. Manufacturers:
 - 1. Listed in Door Hardware Schedule: Trimco
 - 2. Approved Substitutions: Rockwood, Hiawatha, Don-Jo
- B. Types: Armor Plates, Kick Plates, Mop Plates
- C. Fasteners: Provide manufacturer's standard exposed Phillips head fasteners for door trim units; either machine screws or self tapping sheet metal type screws per manufacturer's recommendations for application to the specified door construction.
- D. Sizes: Fabricate protection plates (armor, kick or mop) not more than 2" less than door width on stop side and not more than 1" less than door width on pull side, x the height indicated.
- E. Plastic Laminate Plates: 1/8" thick. Finish as noted, beveled four edges (B4E).

2.12 GASKETS AND SWEEPS

- A. Manufacturer:
 - 1. Listed in Door Hardware Schedule: National Guard Products
 - 2. Approved Substitutions: Pemko, Zero
- B. General: Except as otherwise indicated, provide continuous weatherstripping at each edge of every exterior door leaf. Provide type, sizes and profiles indicated as drawn or scheduled.
- C. Fasteners: Provide non-corrosive fasteners as recommended by the manufacturer for applications indicated.
- D. Replaceable seal strips: Provide only those units where resilient or flexible seal strip is easily replaceable and readily available from stocks maintained by the manufacturer.
- E. Perimeter weatherstripping: Flexible, hollow neoprene bulb or loop insert, conforming to MIL R 6055, Class II, Grade 40.
- F. Weatherstripping at Door Bottoms: Provide door bottoms consisting of contact type resilient insert and metal housing of design and size indicated.
- G. Hot smoke seal, if required by IBC and subsequent UL testing procedures, will be supplied as an integral part of the door assembly by the door manufacturer.
- H. Gaskets and sweeps shall be warranted for a period of three years.

2.13 SILENCERS

- A. Manufacturers:
 - 1. Listed in Door Hardware Schedule: Trimco
 - 2. Approved Substitutions: Rockwood, Ives

2.14 FINISHES

- A. Exposed surfaces of hardware shall be Powder Coated Black (622) unless otherwise indicated.
- B. The designations used in the schedule and elsewhere to indicate hardware finishes are the industry recognized standard commercial finishes common to the product's manufacturer listed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Under provisions of Division 1, examine and verify that substrates and project site conditions are ready to receive work of this section.
- B. Do not begin installation until finishes indicated to be field applied have been applied to doors, frames, and similar items requiring project site finishing and are thoroughly dry and cured.
- C. Do not begin installation until unsatisfactory conditions are corrected in a manner acceptable to the installer. Beginning installation means installer accepts project site conditions and substrates as ready to receive work of this section.

3.02 INSTALLATION

- A. General: The types and approximate quantities of door hardware required for this project are indicated at the end of this section.
- B. Key Cabinet: Install in location as indicated on drawings or as directed by the Architect.
- C. Heights: Mount hardware units at heights indicated in "Recommended Locations for Builders Hardware for /standard Steel Doors and Frames" by the Door and Hardware Institute, except as specifically indicated or required to comply with governing regulations, and except as may be otherwise directed by the Architect.
- D. Substrates: Adjust and reinforce attachment substrates as necessary for proper installation and operation of hardware.
- E. Installation:
 - 1. Install each hardware item in compliance with the manufacturer's instructions, requirements of NFPA 80, NFPA 101, IBC, ADA, State Rules and Regulations for Barrier Free Facilities and recommendations of the DHI.
 - 2. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
 - 3. Drill and countersink units which are not factory prepared for fasteners. Space fasteners and anchors in accordance with industry standards.
 - 4. Where not factory machined, machine cut for hardware per template, as required.
 - 5. Cut and fit thresholds and floor covers to profile of door frames. Join units with concealed welds. Cut smooth openings for spindles, bolts, or similar items. Screw thresholds to substrate with the manufacturer's standard machine screws/expansion anchors (MS/EA) or as otherwise specified. Fill cavities of thresholds at sound rated openings with 1 inch thick (uncompressed thickness) low density fiberglass sill sealer insulation full width and length of the threshold. In addition to fastening requirements, set thresholds for exterior doors in a full bed of butyl-rubber or polyisobutylene mastic sealant.
 - 6. Do not install hardware which is incomplete or apparently improper for application. Notify the hardware supplier immediately of any such deficiencies. Failure to comply with this requirement indicates the hardware installer's acceptance of responsibility for proper application and performance.
 - 7. Where new hardware is to be installed on existing doors, ensure that the door and frame components can accept the new specified hardware. Notify the architect and the owner where hardware cannot be properly installed or if additional hardware is required for an operational application.
- F. Cutting and Patching:

Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, coordinate removal, storage and reinstallation or application of surface protections with finishing work specified in the Division-9 sections.

3.03 ADJUSTING

- A. Initial Adjustment:
 - 1. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Adjust resilient faced sound stops for continuous contact with door and threshold. Adjust weatherstripping and sweeps to completely seal doors with frames and to adjacent structures.
 - 2. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application made.
- B. Final Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

3.04 DEMONSTRATION

Instruct Owner's personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

3.05 CLEANING AND DEBRIS

- A. Cleaning:
 - 1. Clean work under provisions of Division 1
 - 2. Clean adjacent surfaces soiled by work of this section.
- B. Debris: Under provisions of Division 1, remove debris from project site and legally dispose of off-site.

3.06 MAINTENANCE

- A. Approximately six months after the acceptance of hardware in each area, the hardware installer shall:
 - 1. Return to the project and re-adjust every item of hardware to restore proper function of doors and hardware.
 - 2. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
 - 3. Replace hardware items which have deteriorated or failed due to faulty design, materials or installation of hardware units.
 - 4. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware and submit to the Architect.

3.07 PROTECTION

Under provisions of Division 1, protect work of this section as required so that work will be without damage or deterioration at the time of completion and acceptance by the Owner.

3.08 DOOR HARDWARE SCHEDULE

List of Manufacturers

AB	ABH	Overhead Stops
BE	Best Access	Closers
DM	Dorma USA	Locks, Cylinders, Exit Devices, Operators
KD	Keedex	Weldable Lock Box
NA	National Guard	Gaskets, Thresholds
PR	Precision	Power Supplies, Power Transfers
RO	Rockwood	Decorative Pulls
SO	Soss	Invisible Hinges
ST	Stanley	Hinges, Wire Harnesses
TR	Trimco	Stops, Flat Goods

Finish Codes

<u>Code</u>	<u>Description</u>
600	Primed for Field Painting
622	Flat Black Coated
626/652	Satin Chrome Plated
630	Satin Stainless Steel (Operator Switches)
689	Painted Aluminum
693	Painted Black
BLK	Black
BPC	Black Powder Coat

Option List

<u>Code</u>	<u>Description</u>
D	Conventional Cylinder (Dorma)
RB-Kwy	Russwin D1 6-pin
MLR	Motorized Latch Retraction (Dorma)
MS	Touchbar Monitor Switch (Dorma)
LFSF	Electric Locking Trim, Fail Safe (Dorma)
B4E	Beveled 4 Edges - Kick and Mop Plates (Trimco)
CS	Countersunk Screws (Trimco)
MS/EA	Machine Screws/Expansion Anchors (NGP)
SMS-TEKS	Self Drilling Machine Screws (NGP)

SET #1 - Corridor/Open Office

Doors: 102, 112

4	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
1	Passage Set	M9010 L110A	622	DM
1	Closer	HD7016 SPA	693	BE
1	Floor Stop	W1211	622	TR
3	Door Silencers	1229A	BLK	TR

SET #2 - Storage

Door: 205

4	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
1	Passage Set	M9010 L110A	622	DM
1	Floor Stop	W1211	622	TR
3	Door Silencers	1229A	BLK	TR

SET #3 - Office

Doors: 125, 126A, 127, 128A

4	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
1	Lockset	M9050D L110A RB-Kwy	622	DM
1	Floor Stop	W1211	622	TR
1	Coat Hook	3070-1	622	TR
3	Door Silencers	1229A	BLK	TR

SET #4 - IDF/IT Build

Doors: 114, 211

4	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
1	Lockset	M9080D L110A RB-Kwy	622	DM
1	Closer	HD7016 JT	693	BE
1	Floor Stop	W1211	622	TR
1	Gasketing	5050 B Head & Jambs		NA

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Redevelopment**
Steamboat Springs, Colorado

SET #4A - IDF

Doors: 212, 224

3	Hinges	CB179 4 1/2 X 4 1/2 NRP	BLK	ST
1	Lockset	M9080D L110A RB-Kwy	622	DM
1	Closer	HD7016 SPA	693	BE
1	Floor Stop	W1211	622	TR
1	Gasketing	5050 B Head & Jambs		NA

Modify existing door and frame to accept new hardware as specified.

SET #5 - Restroom - Automatic

Doors: 104, 105, 209, 210

4	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
1	Pull Plate	1018-3	622	TR
1	Push Plate	1001-9	622	TR
*1	Operator/Switches	Specified in Section 087113		
1	Kick Plate	K6000 10" x 2" LDW B4E CS	BLK	TR
1	Floor Stop	W1211	622	TR
1	Gasketing	5050 B Head & Jambs		NA

SET #7 - AGR/Shower/Mother's Room

Doors: 116, 117, 214, C205

4	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
1	Privacy w/Indicator	M9046 L110A	622	DM
1	Closer	HD7016 JT	693	BE
1	Floor Stop	W1211	622	TR
1	Gasketing	5050 B Head & Jambs		NA

SET #8 - Entrance - Card Access - Automatic

Doors: 100A, P.001B, P.001C

2	Continuous Hinges	661HD EPT	BLK	ST
*2	Power Transfers	EPT-12C		PR
*1	Exit Device	9600BB MLR MS	693	DM
*1	Exit Device	9600BB D MLR MS RB-Kwy	693	DM
2	Offset Pulls	RM4190 48" x 14XHD	BPC	RO
*1	Operator/Switches	Specified in Section 087113		
2	Door Stops	1214H	622	TR
2	Door Sweeps	200 NGBL SMS-TEKS		NA
1	Thermal Break Threshold	8426 GBL MS/EA		NA
*2	Wire Harnesses	WH-6E		ST
*2	Wire Harnesses	WH-12P		ST
*2	Wire Harnesses	WH-192		ST
*1	Power Supply	RPSMLR2		PR

Card activation momentarily retracts latches, energizes exterior operator switch and allows access. Inside operator switch always active. Card reader by security access. Coordinate operation per 1.05-A-6. Mount pulls not to conflict with vertical rods. Verify threshold application.

SET #9 - Vestibule - Card Access - Automatic

Door: 100B, P.001A, P.001D

2	Continuous Hinges	661HD EPT	BLK	ST
*2	Power Transfers	EPT-12C		PR
*1	Exit Device	9600BB MLR MS	693	DM
*1	Exit Device	9600BB D MLR MS RB-Kwy	693	DM
2	Offset Pulls	RM4190 48" x 14XHD	BPC	RO
*1	Operator/Switches	Specified in Section 087113		
2	Door Stops	1214H	622	TR
*1	Console	CC402DTM		DM
*2	Wire Harnesses	WH-6E		ST
*2	Wire Harnesses	WH-12P		ST
*2	Wire Harnesses	WH-192		ST
*1	Power Supply	RPSMLR2		PR

Modify existing doors and frame to accept new hardware as specified. Notify the architect of any installation issues. Card activation momentarily retracts latches, energizes exterior operator switch and allows access. Inside operator switch always active. Card reader by security access. Coordinate and locate remote switch as directed. Coordinate operation per 1.05-A-6. Mount pulls not to conflict with vertical rods. Gaskets by frame manufacturer.

SET #10 - Stair

Doors: 108A, 130

4	Hinges	CB168 4 1/2 X 4 1/2	BLK	ST
1	Exit Device	F9300B x YL11023	693	DM
1	Closer	HD7016 JT	693	BE
1	Floor Stop	W1211	622	TR
1	Gasketing	5050 B Head & Jambs		NA

SET #10A - Stair - Card Access

Doors: A301

2	Hinges	CB168 4 1/2 X 4 1/2 NRP	BLK	ST
*1	Electric Hinge	CECB168-12C 4 1/2 x 4 1/2	BLK	ST
*1	Exit Device	F9300B x YL11008D LFSF MS RB-Kwy	693	DM
1	Closer/Stop	HD7016 SDS	693	BE
1	Gasketing	5050 B Head & Jambs		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-12P		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	RPSMLR2		PR

Device is fail safe per code. Must unlock on fire alarm. Card reader by security access.

SET #11 - Stair Exit - Card Access

Door: 108B

2	Hinges	CB199 4 1/2 X 4 1/2 NRP	BLK	ST
*1	Electric Hinge	CECB199-12C 4 1/2 x 4 1/2	BLK	ST
*1	Exit Device	9300B D MLR MS RB-Kwy	693	DM
1	Offset Pull	RM4190 48" x 14XHD	BPC	RO
1	Closer	HD7016 SPA	693	BE
1	Door Stop	1214H	622	TR
1	Gasketing	700 NGBL SMS-TEKS		NA
1	Door Sweep	200 NGBL SMS-TEKS		NA
1	Threshold	898 NDKB MS/EA		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-12P		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	RPSMLR2		PR

Modify existing door and frame to accept new hardware as specified. Do not cut weatherstrip - template hardware accordingly. Verify threshold application. Card activation momentarily retracts latch and allows access. Card reader by security access.

SET #11A - Stair - Card Access

Doors: 208, 230

3	Hinges	CB168 4 1/2 X 4 1/2 NRP	BLK	ST
*1	Electric Hinge	CECB168-12C 4 1/2 x 4 1/2	BLK	ST
*1	Exit Device	F9300B x YL11008 D LFSF RB-Kwy	693	DM
1	Closer	HD7016 JT	693	BE
1	Floor Stop	W1211	622	TR
1	Gasketing	5050 B Head & Jambs		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-12P		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	RPSMLR2		PR

Device is fail safe - must release on alarm. Card activation momentarily unlocks trim and allows access. Card reader by security access.

SET #12 - Existing Patio

Doors: 113B, 126B, 128B, 201A, 201B, 204B, 206A, 206B, 216A, 216B, 216C, 219B

3	Hinges	CB199 4 1/2 X 4 1/2	BLK	ST
1	Lockset	M9973D L110A RB-Kwy Less OS Trim	622	DM
1	Closer/Stop	HD7016 IS	693	BE

Modify existing door and frame to accept new hardware as specified. Balance reuse existing. Cylinder on exterior side to allow key access from the exterior - verify if acceptable to local jurisdiction.

SET #13 - Storage

Doors: 120A, A321, A321A, A305

8	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
2	Single Dummy	M9001 L110A	622	DM
2	Roller Latches	1559W A-STRIKE	622	TR
1	Floor Stop	W1211	622	TR
1	Overhead Stop	4420 SERIES	BLK	AB
2	Door Silencers	1229A	BLK	TR

SET #13A - Storage

Door: 120B,

8	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
2	Single Dummy	M9001 L110A	622	DM
2	Roller Latches	1559W A-STRIKE	622	TR
2	Overhead Stops	4420 SERIES	BLK	AB
2	Door Silencers	1229A	BLK	TR

SET #14 - Reception

Door: 101

4	Concealed Hinge	218	622	SO
1	Lockset	M9080D L110A RB-Kwy Less OS Trim	622	DM
1	Floor Stop	W1211	622	TR
3	Door Silencers	1229A	BLK	TR
Cylinder only on pull side - key serves as pull.				

SET #15 - Existing Office - Card Access

Door: A201

1	Continuous Hinge	661HD	BLK	ST
1	Lockset	8856.134.Dorma L110A	693	AC
*1	Electric Strike	BES-F41148	630	BE
1	Mortise Cylinder	90X Series RB-Kwy	693	DM
1	Closer/Stop	HD7016 SDS DP70	693	BE
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	DKPS-2A		RC

Modify existing door and frame to accept new hardware as specified. Card activation momentarily releases strike and allows access. Card reader by security access. Balance reuse existing.

SET #16 - Break Room/Entrance - Card Access - Automatic

Doors: A302, A328A

1	Continuous Hinge	661HD	BLK	ST
1	Exit Device	9700BB D CD RB-Kwy	693	DM
1	Offset Pull	RM4190 48" x 14XHD	BPC	RO
*1	Electric Strike	BES-0162	630	DM
*1	Operator/Switches	Specified in Section 087113		
*1	Wire Harnesses	WH-6E		ST
*1	Wire Harnesses	WH-192		ST
*1	Power Supply	DKPS-2		RC

Card activation momentarily releases strike, energizes exterior operator switch and allows access. Inside operator switch always active. Card reader by security access. Coordinate operation per 1.05-A-6. Balance reuse existing.

SET #17 - Existing Door

Door: A303, A400A, A400B

Reuse existing hardware.

SET #18 - Wellness/AGR/Shower

Doors: A309, A326

3	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
1	Privacy w/Indicator	M9046 L110A	622	DM
1	Closer	HD7016 JT	693	BE
1	Floor Stop	W1211	622	TR
1	Gasketing	5050 B Head & Jambs		NA

SET #19 - Electrical - Card Access

Door: A312

3	Hinges	CB168 4 1/2 X 4 1/2 NRP	BLK	ST
1	Exit Device	9300BB x YL11003R D LD RB-Kwy	693	DM
*1	Electric Strike	BES-0162	630	DM
1	Closer/Stop	HD7016 SDS	693	BE
1	Gasket	5050B Head & Jambs		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	DKPS-2		RC

Card activation momentarily releases strike and allows access. Card reader by security access.

SET #20 - IDF/Storage - Card Access

Doors: A314, A317, A318, A327

7	Hinges	CB179 4 1/2 X 4 1/2 NRP	BLK	ST
*1	Electric Hinge	CECB179-12C 4 1/2 X 4 1/2	BLK	ST
2	Flush Bolts	3917-12	622	TR
1	Dust Proof Strike	3911	622	TR
*1	Electrified Lockset	M9080D EU L110A RB-Kwy RX	622	DM
2	Closers	HD7016 SPA	693	BE
2	Floor Stops	W1211	622	TR
1	Gasket	5050B Head & Jambs		NA
1	Astragal	139 A GBL		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-44P		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	DKPS-2		RC

Inactive leaf for movement of materials only. Apply astragal to inactive leaf. Card activation momentarily releases lever and allows access. Card reader by security access.

SET #20A - Storage - Card Access

Door: F208

5	Hinges	CB179 4 1/2 X 4 1/2 NRP	BLK	ST
*1	Electric Hinge	CECB179-12C 4 1/2 X 4 1/2	BLK	ST
2	Flush Bolts	3917-12	622	TR
1	Dust Proof Strike	3911	622	TR
*1	Electrified Lockset	M9080D EU L110A RB-Kwy RX	622	DM
2	Closers	HD7016 SPA	693	BE
2	Floor Stops	W1211	622	TR
1	Gasket	5050B Head & Jambs		NA
1	Astragal	139 A GBL		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-44P		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	DKPS-2		RC

Inactive leaf for movement of materials only. Apply astragal to inactive leaf. Card activation momentarily releases lever and allows access. Card reader by security access.

SET #21 - Existing Office

Door: A320A

1	Continuous Hinge	661HD	BLK	ST
1	Lockset	8856.134.Dorma L110A	693	AC
1	Mortise Cylinder	90X Series RB-Kwy	693	DM
1	Closer/Stop	HD7016 SDS DP70	693	BE

Modify existing door and frame to accept new hardware as specified. Notify the architect and owner of any installation issues. Balance reuse existing.

SET #22 - Restroom

Doors: A322, A323

3	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
1	Pull Plate	1018-3	622	TR
1	Push Plate	1001-9	622	TR
1	Closer	HD7016 JT	693	BE
1	Kick Plate	K6000 10" x 2" LDW B4E CS	BLK	TR
1	Floor Stop	W1211	622	TR
1	Gasketing	5050 B Head & Jambs		NA

SET #22A - Restroom

Doors: C203, C204

4	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
1	Pull Plate	1018-3	622	TR
1	Push Plate	1001-9	622	TR
1	Closer	HD7016 JT	693	BE
1	Kick Plate	K6000 10" x 2" LDW B4E CS	BLK	TR
1	Floor Stop	W1211	622	TR
1	Gasketing	5050 B Head & Jambs		NA

SET #23 - Vestibule - Automatic

Door: A328B

1	Continuous Hinge	661HD	BLK	ST
1	Push Bar	1741 Type N Mounting	622	TR
1	Offset Pull	RM4190 48" x 14XHD	BPC	RO
*1	Operator/Switches	Specified in Section 087113		
1	Floor Stop	W1211	622	TR

Gaskets by door manufacturer.

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SET #24

Doors:

NOT USED

SET #24A - Storage - Card Access

Door: C206

3	Hinges	CB179 4 1/2 X 4 1/2 NRP	BLK	ST
*1	Electric Hinge	CECB179-12C 4 1/2 X 4 1/2	BLK	ST
*1	Electrified Lockset	M9080D EU L110A RB-Kwy RX	622	DM
1	Closer	HD7016 SPA	693	BE
1	Floor Stop	W1211	622	TR
1	Gasket	5050B Head & Jambs		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-44P		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	DKPS-2		RC

Card activation momentarily releases lever and allows access. Card reader by security access.

SET #25 - Office

Doors: A405, F202, F203, F204

3	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
1	Passage Latch	M9010 L110A	622	DM
1	Closer	HD7016 JT	693	BE
1	Floor Stop	W1211	622	TR
3	Silencers	1229A	GREY	TR

SET #26 - Lockers - Card Access - Automatic

Doors: C201A, F201, F207A

1	Continuous Hinge	661HD EPT	BLK	ST
*1	Power Transfer	EPT-12C		PR
*1	Exit Device	9700BB D MLR MS RB-Kwy	693	DM
1	Offset Pull	RM4190 48" x 14XHD	BPC	RO
*1	Operator/Switches	Specified in Section 087113		
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-12P		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	RPSMLR2		PR

Card activation momentarily retracts latch, energizes exterior operator switch and allows access. Inside operator switch always active. Card reader by security access. Coordinate

operation per 1.05-A-6. Modify existing door and frame to accept new hardware as specified. Balance reuse existing.

SET #26A - Lockers - Card Access - Automatic

Door: C207

2	Continuous Hinges	661HD EPT	BLK	ST
*2	Power Transfers	EPT-12C		PR
*1	Exit Device	9800BB D LB MLR MS RB-Kwy	693	DM
*1	Exit Device	9800BB LB MLR MS	693	DM
2	Offset Pulls	RM4190 48" x 14XHD	BPC	RO
*1	Operator Set/Switches	Specified in Section 087113		
*2	Wire Harnesses	WH-6E		ST
*2	Wire Harnesses	WH-12P		ST
*2	Wire Harnesses	WH-192		ST
*1	Power Supply	RPSMLR2		PR

Card activation momentarily retracts latches, energizes exterior operator switch and allows access. Inside operator switch always active. Card reader by security access. Coordinate operation per 1.05-A-6. Modify existing door and frame to accept new hardware as specified. Mount pulls not to conflict with vertical rods. Balance reuse existing.

SET #27 - Lockers - Exit Only

Doors: C201B, C201C, C201D

1	Continuous Hinge	661HD	BLK	ST
1	Exit Device	9700BB	693	DM
1	Closer/Stop	HD7016 SDS DP70	693	BE

Exit only. Modify existing door and frame to accept new hardware as specified. Balance reuse existing.

SET #28 - Storage - Card Access

Door: C202

2	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
*1	Electric Hinge	CECB179-12C 4 1/2 X 4 1/2	BLK	ST
*1	Electrified Lockset	M9080D EU L110A RB-Kwy RX	622	DM
1	Closer	HD7016 JT	693	BE
1	Floor Stop	W1211	622	TR
3	Silencers	1229A	GREY	TR
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-44P		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	DKPS-2		RC

Card activation momentarily releases lever and allows access. Card reader by security access.

SET #29 - Mechanical Access

Door: F207B

3	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
1	Passage Latch	M9010 L110A	622	DM
1	Floor Stop	W1211	622	TR
3	Silencers	1229A	GREY	TR

SET #30 - Goldwalk Boiler Room

Door: GW100A

6	Hinges	CB179 4 1/2 X 4 1/2 NRP	652	ST
1	Set Auto Flush Bolts	3810 X 3810	626	TR
1	Dust Proof Strike	3911	630	TR
1	Lockset	M9080D L110A RB-Kwy	626	DM
1	Coordinator	3093	626	TR
1	Closer (inactive)	HD7016 SPA	689	BE
*1	Hold Open Closer	8916 EMF/PT	689	DM
2	Kick Plates	K0050 10" x 2" LDW B4E CS	630	TR
2	Floor Stops	W1211	630	TR
1	Gasket	5050B Head & Jambs		NA
1	Sweep	A605 A SMS-TEKS		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	DKPS-2A		RC

Astragal on inactive leaf by door manufacturer. Hold open must release on alarm. Mount stops not to pose a tripping hazard.

SET #31 - Goldwalk Boiler Room

Doors: GW100B, GQ100C, GW100D, GW100E

8	Hinges	CB179 4 1/2 X 4 1/2 NRP	652	ST
1	Set Auto Flush Bolts	3810 X 3810	626	TR
1	Dust Proof Strike	3911	630	TR
1	Lockset	M9080D L110A RB-Kwy	626	DM
1	Coordinator	3093	626	TR
*2	Hold Open Closers	8916 EMF/PT	689	DM
2	Kick Plates	K0050 10" x 2" LDW B4E CS	630	TR
2	Floor Stops	W1211	630	TR
1	Gasket	5050B Head & Jambs		NA
2	Sweeps	A605 A SMS-TEKS		NA
*2	Wire Harnesses	WH-6E		ST
*2	Wire Harnesses	WH-192		ST
*1	Power Supply	DKPS-2A		RC

Astragal on inactive leaf by door manufacturer. Hold open must release on alarm. Mount stops not to pose a tripping hazard.

SET #32 - Goldwalk Storage

Door: GW101

8	Hinges	CB179 4 1/2 X 4 1/2	652	ST
1	Set Auto Flush Bolts	3810 X 3810	626	TR
1	Dust Proof Strike	3911	630	TR
1	Lockset	M9080D L110A RB-Kwy	622	DM
1	Coordinator	3094 Series	BLK	TR
2	Closers	HD7016 JT	689	BE
2	Kick Plates	K0050 10" x 2" LDW B4E CS	630	TR
2	Floor Stops	W1211	630	TR
1	Gasket	5050B Head & Jambs		NA
2	Sweeps	A605 A SMS-TEKS		NA

Astragal on inactive leaf by door manufacturer. Mount stops not to pose a tripping hazard.

SET #33 - Promenade Overhead Door

Doors: P.004B, P.005C

1	Mortise Cylinder	90X Series RB-Kwy	622	DM
	Balance by door manufacturer.			

SET #33A - Goldwalk Gate

Gate: GW101A

1	Weldable Lock Box	KBXMOR Series	600	KD
1	Lockset	M9080D L110A RB-Kwy	626	DM
Balance by the gate manufacturer.				

SET #34 - Goldwalk Mechanical/Electrical

Doors: GW104, GW105, GW107

3	Hinges	CB179 4 1/2 X 4 1/2 NRP	652	ST
1	Lockset	M9080D L110A RB-Kwy	626	DM
1	Kick Plate	K0050 10" x 2" LDW B4E CS	630	TR
1	Floor Stop	W1211	630	TR
1	Gasket	5050B Head & Jambs		NA

SET #34A - Storage

Door: A305

3	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
1	Lockset	M9080D L110A RB-Kwy	622	DM
1	Floor Stop	W1211	622	TR
3	Silencers	1229A	BLK	NA

SET #34B - Goldwalk Mechanical/Electrical

Door: GW102

3	Hinges	CB179 4 1/2 X 4 1/2 NRP	652	ST
1	Lockset	M9080D L110A RB-Kwy	626	DM
1	Closer	HD7016 SPA	689	BE
1	Kick Plate	K0050 10" x 2" LDW B4E CS	630	TR
1	Floor Stop	W1211	630	TR
1	Gasket	5050B Head & Jambs		NA
1	Sweep	A605 A SMS-TEKS		NA

SET #35 - Goldwalk Mechanical Exterior

Door: GW103

3	Hinges	CB199 4 1/2 X 4 1/2 NRP	BLK	ST
1	Lockset	M9080D L110A RB-Kwy	622	DM
1	Closer/Stop	HD7016 SDS	693	BE
1	Kick Plate	K0050 10" x 2" LDW B4E CS	630	TR
1	Gasketing	700 NGBL SMS-TEKS		NA
1	Sweep	200 NGBL SMS-TEKS		NA
1	Threshold	898 NDKB MS/EA		NA

Do not cut weatherstrip - template hardware accordingly. Verify threshold application.

SET #36 - Goldwalk Vestibule

Door: GW106

3	Hinges	CB179 4 1/2 X 4 1/2 NRP	652	ST
1	Lockset	M9050D L110A RB-Kwy	626	DM
1	Closer	HD7016 SPA	689	BE
1	Kick Plate	K0050 10" x 2" LDW B4E CS	630	TR
1	Wall Stop	1270WV	630	TR
1	Gasket	5050B Head & Jambs		NA

SET #37 - Goldwalk - Retail - Card Access - Automatic

Door: GW300

1	Continuous Hinge	661HD EPT	BLK	ST
*1	Power Transfer	EPT-12C		PR
*1	Exit Device	9700BB D MLR MS RB-Kwy	693	DM
1	Offset Pull	RM4190 48" x 14XHD	BPC	RO
*1	Operator/Switches	Specified in Section 087113		
1	Sweep	200 NGBL SMS-TEKS		NA
1	Thermal Break Threshold	8426 GBL MS/EA		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-12P		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	DKPS-2		RC

Card activation momentarily releases strike, energizes exterior operator switch and allows access. Inside operator switch always active. Card reader by security access. Coordinate operation per 1.05-A-6. Gaskets by door manufacturer. Verify threshold application.

SET #38 - Promenade Mechanical/Electrical

Doors: P.005A, P.005B, P.002A

3	Hinges	CB168 4 1/2 X 4 1/2 NRP	BLK	ST
1	Exit Device	F9300B x YL11003R D RB-Kwy	622	DM
1	Closer/Stop	HD7016 SDS	693	BE
1	Kick Plate	K6000 10" x 2" LDW B4E CS	BLK	TR
1	Gasket	5050B Head & Jambs		NA

SET #38A - Promenade Electrical

Door: P.002B

3	Hinges	CB199 4 1/2 X 4 1/2 NRP	BLK	ST
1	Exit Device	F9300B x YL11003R D RB-Kwy	622	DM
1	Closer/Stop	HD7016 SDS	693	BE
1	Kick Plate	K6000 10" x 2" LDW B4E CS	BLK	TR
1	Gasketing	700 NGBL SMS-TEKS		NA
1	Sweep	200 NGBL SMS-TEKS		NA
1	Thermal Break Threshold	8426 GBL MS/EA		NA

SET #39 - Promenade Dishwashing - Card Access

Doors: P.006, P.016

2	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
*1	Electric Hinge	CECB179-12C 4 1/2 X 4 1/2	BLK	ST
*1	Electrified Lockset	M9080D EU L110A RB-Kwy RX	622	DM
1	Closer/Stop	HD7016 IS	693	BE
1	Gasket	5050B Head & Jambs		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-44P		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	DKPS-2		RC

Card activation momentarily releases lever and allows access. Card reader by security access.

SET #39A - Promenade Keg/Cold Room - Card Access

Doors: P.012, P.013

2	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
*1	Electric Hinge	CECB179-12C 4 1/2 X 4 1/2	BLK	ST
*1	Electrified Lockset	M9080D EU L110A RB-Kwy RX	622	DM
1	Closer/Stop	HD7016 IS	693	BE
1	Sweep	A607 A GBL SMS-TEKS		NA
1	Gasket	5050B Head & Jambs		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-44P		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	DKPS-2		RC

Card activation momentarily releases lever and allows access. Card reader by security access.

SET #40 - Promenade Electrical/Mechanical

Doors: P.007, P.019, P.020

3	Hinges	CB179 4 1/2 X 4 1/2 NRP	BLK	ST
1	Lockset	M9080D L110A RB-Kwy	622	DM
1	Closer/Stop	HD7016 SDS	693	BE
1	Kick Plate	K6000 10" x 2" LDW B4E CS	BLK	TR
1	Gasket	5050B Head & Jambs		NA

SET #41 - Promenade ERV

Doors: P.008, P.014, P.003

3	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
1	Lockset	M9080D L110A RB-Kwy	622	DM
1	Closer/Stop	HD7016 IS	693	BE
1	Kick Plate	K6000 10" x 2" LDW B4E CS	BLK	TR
1	Gasket	5050B Head & Jambs		NA

SET #42 - Promenade Stair

Door: P.010

3	Hinges	CB168 4 1/2 X 4 1/2 NRP	BLK	ST
1	Exit Device	F9300B x YL11023	622	DM
1	Closer/Stop	HD7016 IS	693	BE
1	Kick Plate	K6000 10" x 2" LDW B4E CS	BLK	TR
1	Gasket	5050B Head & Jambs		NA

SET #43 - Promenade Storage – Card Access

Door: P.011A

5	Hinges	CB179 4 1/2 X 4 1/2	BLK	ST
*1	Electric Hinge	CECB179-12C 4 1/2 X 4 1/2	BLK	ST
1	Set Auto Flush Bolts	3810 X 3810	622	TR
1	Dust Proof Strike	3911	622	TR
*1	Lockset	M9080D EU L110A RB-Kwy RX	622	DM
1	Coordinator	3094 Series	BLK	TR
2	Closer/Stops	HD7016 IS	693	BE
2	Kick Plates	K6000 10" x 2" LDW B4E CS	BLK	TR
1	Gasket	5050B Head & Jambs		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-44		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	DKPS-2A		RC

Astragal on inactive leaf by door manufacturer. Card activation momentarily unlocks trim and allows access.

SET #44 - Promenade Storage - Card Access - Delayed Egress

Door: P.011B

4	Hinges	CB168 4 1/2 X 4 1/2 NRP	BLK	ST
*2	Electric Hinges	CECB168-12C 4 1/2 X 4 1/2	BLK	ST
2	Exit Devices	F9400B x YL11003R D LB MLR MS	693	TR
*2	Maglocks	BML-DE8310S	313	BE
1	Mortise Cylinder	90X Series RB-Kwy	622	DM
2	Closer/Stops	HD7016 IS	693	BE
2	Kick Plates	K6000 10" x 2" LDW B4E CS	BLK	TR
1	Gasket	5050B Head & Jambs		NA
1	Gasket Set	A605 A GBL SET		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-44		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	DKPS-2A		RC

Maglocks are delayed egress - sounds alarm for 15 seconds then allows egress. Card reader (both sides) retracts latches, shunts maglocks and allows egress/access. Provide mounting brackets as required.

SET #45 - Promenade Lockers - Card Access - Delayed Egress

Door: P.015

8	Hinges	CB168 4 1/2 X 4 1/2 NRP	BLK	ST
2	Exit Devices	F9400B LB	693	TR
*1	Maglock	BML-DE8310S	313	BE
1	Mortise Cylinder	90X Series RB-Kwy	622	DM
2	Closers	HD7016 SDS	693	BE
2	Kick Plates	K6000 10" x 2" LDW B4E CS	BLK	TR
1	Gasket	5050B Head & Jambs		NA
1	Astragal	139 SP GBL		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-44		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	DKPS-2A		RC

Double egress door. Maglock is delayed egress - sounds alarm for 15 seconds then allows egress. Card reader (secure sides) shunts maglock and allows egress. Locate maglock as directed. Provide mounting brackets as required. Mount astragal on either leaf.

SET #46 - Promenade IDF/IT - Card Access

Doors: P.017, P.018

2	Hinges	CB179 4 1/2 X 4 1/2 NRP	BLK	ST
*1	Electric Hinge	CECB179-12C 4 1/2 X 4 1/2	BLK	ST
*1	Electrified Lockset	M9080D EU L110A RB-Kwy RX	622	DM
1	Closer/Stop	HD7016 SDS	693	BE
1	Kick Plate	K6000 10" x 2" LDW B4E CS	BLK	TR
1	Gasket	5050B Head & Jambs		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-44P		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	DKPS-2		RC

Card activation momentarily releases lever and allows access. Card reader by security access.

SET #47 - Promenade Loading - Card Access

Door: P.004A

2	Hinges	CB168 4 1/2 X 4 1/2	BLK	ST
*1	Electric Hinge	CECB168-12C 4 1/2 X 4 1/2	BLK	ST
*1	Exit Device	F9300B x YL11003R D MLR MS	622	DM
1	Closer/Stop	HD7016 SDS	693	BE
1	Kick Plate	K6000 10" x 2" LDW B4E CS	BLK	TR
1	Gasket	5050B Head & Jambs		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-12P		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	RPSMLR2		PR

Card activation momentarily retracts latch and allows access. Card reader by security access.

SET #48 - Promenade Loading – Card Access

Door: P.004E

2	Hinges	CB199 4 1/2 X 4 1/2 NRP	BLK	ST
*1	Electric Hinge	CECB199-12C 4 1/2 X 4 1/2	BLK	ST
*1	Exit Device	9300B D MLR MS RB-Kwy	693	DM
1	Offset Pull	RM4190 48" x 14XHD	BPC	RO
1	Closer/Stop	HD7016 SDS	693	BE
1	Kick Plate	K6000 10" x 2" LDW B4E CS	BLK	TR
1	Gasketing	700 NGBL SMS-TEKS		NA
1	Sweep	200 NGBL SMS-TEKS		NA
1	Thermal Break Threshold	8426 GBL MS/EA		NA
*1	Wire Harness	WH-6E		ST
*1	Wire Harness	WH-12P		ST
*1	Wire Harness	WH-192		ST
*1	Power Supply	RPSMLR2		PR

Card activation momentarily retracts latch and allows access. Do not cut weatherstrip - template hardware accordingly. Verify threshold application.

SET #D1 - Demountable Sliding Door – Non Locking

Doors: 106, 109, 110, 121, 122, 123, 217, 218, 219A, 220, 221, 222, A306, A307, A329, A330

All hardware by demountable partition manufacturer.

SET #D2 - Demountable Swinging Door – Non Locking

Doors: 113A, 204A, 215, 223, A304, A308, A316

All hardware by demountable partition manufacturer.

SET #D3 - Demountable Swinging Door - Locking

Doors: A315, A319, A320B

All hardware by demountable partition manufacturer.

* Requires electronic coordination

End of Section 08 71 00

Opening List

<u>Opening</u>	<u>Hdw Set</u>	<u>Opening Label</u>
100A	8	
100B	9	
101	14	
102	1	
104	5	
105	5	
106	D1	
108A	10	90
108B	11	
109	D1	
110	D1	
112	1	
113A	D2	
113B	12	
114	4	
116	7	
117	7	
120A	13	
120B	13A	
121	D1	
122	D1	
123	D1	
125	3	
126A	3	
126B	12	
127	3	
128A	3	
128B	12	
130	10	90
201A	12	
201B	12	
204A	D2	
204B	12	
205	2	
206A	12	
206B	12	
208	11A	90
209	5	
210	5	
211	4	
212	4A	
214	7	
215	D2	
216A	12	
216B	12	
216C	12	
217	D1	
218	D1	

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219A	D1	
219B	12	
220	D1	
221	D1	
222	D1	
223	D3	
224	4A	
230	11A	90
A201	15	
A301	10A	90
A302	16	
A303	17	
A304	D2	
A305	13	
A306	D1	
A307	D1	
A308	D2	
A309	18	
A312	19	
A314	20	
A315	D3	
A316	D2	
A317	20	
A318	20	
A319	D3	
A320A	21	
A320B	D3	
A321	13	
A321A	13	
A322	22	
A323	22	
A326	18	
A327	20	
A328A	16	
A328B	23	
A329	D1	
A330	D1	
A400A	17	
A400B	17	
A405	25	
A406	D2	
C201A	26	
C201B	27	
C201C	27	
C202	28	
C203	22A	
C204	22A	
C205	7	
C206	24A	
C207	26A	
F201	26	
F202	25	
F203	25	
F204	25	

F205	D1	
F206	18	
F207A	26	
F207B	29	
F208	20A	
F209	24	
GW100A	30	45
GW100B	31	45
GW100C	31	45
GW100D	31	45
GW100E	31	45
GW101A	32	45
GW101B	33A	
GW102	34B	
GW103	35	
GW104	34	
GW105	34	
GW106	36	
GW300	37	
P.001B	8	
P.001C	8	
P.005A	38	
P.006	39	
P.007	40	
P.008	41	
P.010	42	90
P.011A	43	
P.011B	44	
P.012	39A	
P.013	39A	
P.014	41	
P.015	45	90
P.016	39	
P.017	46	
P.018	46	
P.019	40	
P.020	40	
P.002A	38	90
P.002B	38A	
P.003	41	
P.004A	47	
P.004B	33	
P.004C	33	
P.004D	33	
P.004E	48	
P.005B	38	
P.005C	33	

SECTION 08 71 13 - AUTOMATIC DOOR OPERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section includes the following types of automatic door operators:
 - 1. Low-energy door operators for swinging doors.
- B. Related Sections:
 - 1. Division 7 Sections for caulking to the extent not specified in this section.
 - 2. Division 8 Sections for "Aluminum-Framed Entrances and Storefronts" for entrances furnished and installed separately in Division 8 Section.
 - 3. Division 8 Section "Door Hardware" for hardware to the extent not specified in this section.
 - 4. Division 8 Section "Glazing" for materials and installation requirements of glazing for automatic entrances.
 - 5. Division 26 and 28 Sections for electrical connections including conduit and wiring for automatic entrance operators and access-control devices.

1.3 REFERENCES

- A. References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. CUL - Approved for use in Canada.
 - 4. NFPA 70 - National Electrical Code.
 - 5. NFPA 80 - Fire Doors and Windows.
 - 6. NFPA 101 - Life Safety Code.
 - 7. NFPA 105 - Installation of Smoke Door Assemblies.
- B. American National Standards Institute (ANSI) / Builders Hardware Manufacturers Association (BHMA).

1. ANSI/BHMA A156.19 Standards for Power Assist and Low Energy Power Operated Doors.
- C. Underwriters Laboratories (UL).
 1. UL10C - Positive Pressure Fire Tests of Door Assemblies.
 2. UL 325 - Standard for Safety for Door, Drapery, Gate, Louver, and Window Operators and Systems.
- D. American Association of Automatic Door Manufacturers (AAADM).
- E. American Society for Testing and Materials (ASTM).
 1. ASTM B221 Standard Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
 2. ASTM B209 Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.
- F. American Architectural Manufacturers Association (AAMA).
 1. AAMA 611 Voluntary Specification for Anodized Architectural Aluminum.
- G. National Association of Architectural Metal Manufacturers (NAAMM).
 1. Metal Finishes Manual for Architectural Metal Products.
- H. International Code Council (IBC).
 1. IBC: International Building Code Building Code.

1.4 DEFINITIONS

- A. Activation device: Device that, when actuated, sends an electrical signal to the door operator to initiate the door operation.
- B. Monitored Safety Devices: A tested system that works in conjunction with the automatic door control that detects the presence of a person or an object within a zone where contact could occur and provides a signal to stop the movement of the door.
- C. AAADM: American Association of Automatic Door Manufacturers.
- D. Operating ambient Temperature Range: 5 Degrees F to plus 122 degrees F (minus 15 C to 50 degrees C).
- E. For automatic door terminology, refer to ANSI/BHMA A 156.19 for definitions of terms.

1.5 PERFORMANCE REQUIREMENTS

- A. General: Provide automatic doors that have been designed and fabricated to comply with specified performance requirements, as demonstrated by testing manufacturers corresponding systems.
- B. Compliance:
 - 1. ICC/IBC International Building Code
 - 2. ANSI/BHMA A 156.19 American National Standard for Power Operated Doors Pedestrian Doors.
 - 3. UL 325 Listed
 - 4. NFPA 70 National Electrical Code.
 - 5. NFPA 101 Life Safety Code
 - 6. CUL Approved for use in Canada
 - 7. UL Listed Fire Door Operator with Automatic Closer
- C. Automatic Door equipment accommodates medium to heavy pedestrian traffic.
- D. Opening Force Requirements:
 - 1. Power-Operated swinging doors shall open with a manual force not to exceed 30 lbf to set the door in motion and 15 lbf to fully open the door with force applied at 1" (25mm) from the latched edge of the door. The required force to prevent a stopped door from opening or closing shall to exceed 15 lbf measured 1" (25mm) from the latch edge of the door at any point during the opening or closing.
- E. Closing Time:
 - 1. Door operators shall be field adjustable to close 90 degrees to 10 degrees in 3 seconds or longer per ANSI/BHMA A 156.19 standard.
 - 2. Door shall be field adjusted to close from 10 degrees to fully closed position in not less than 1.5 seconds.

1.6 SUBMITTALS

- A. Comply with Division 01 - Submittal Procedures.
- B. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles fabrication, operational descriptions and finishes.
- C. Shop Drawings: For automatic entrances. Include plans, elevations, sections, details, hardware mounting heights, additional accessories and attachments to other work.

- D. Samples: color samples of exposed finish as required.
- E. Informational Submittals: Manufacturers product information and applicable sustainability program credits that are available towards a LEED rated product certification.
 - 1. Credit MR 4.1 and 4.2: Manufacture's or fabricator's certificate indicating percentage of post-consumer recycled content by weight and pre-consumer recycled content by weight for each product specified under this section.
- F. Manufacturers Field Reports: Submit manufacturer's field reports from AAADM certified technician of inspection and approval of doors for compliance with ANSI/BHMA A 156.19 after completion of installation.
- G. Operating and Maintenance Manuals: Provide manufacturers operating, owners and maintenance manuals for each item specified as required in Division 01, Closeout Submittals.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: 10 years minimum of documented experience in manufacturing door equipment similar to that indicated within this specification with a proven record of successful service performance. A manufacturer with company certificate issued by AAADM.
- B. Installer Qualifications: Installers, trained by the primary product manufacturers, with a minimum 5 years documented experience installing and maintenance of units similar in material, design, and extent to that indicated in this specification and whose work has resulted in construction with a record of successful in-service performance. Manufacturer's authorized representative who is trained and approved for installation and maintenance of units by AAADM required for this Project
- C. Source Limitations for Automatic Operators: Obtain each type of automatic door operator and sensor components specified in this section from single source from single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Power-Operated Door Standard: ANSI/BHMA A 156.19 Current year.
- F. Emergency-Exit Door Requirements: Comply with requirements of authorities having jurisdiction for automatic entrances serving as a required means of egress.

1.8 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings to receive automatic entrances by field measurements before fabrication.

1.9 COORDINATION

- A. Coordinate door operators with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish. Coordinate hardware for automatic entrances with hardware required for rest of project.
- B. Electrical System Roughing-in: Coordinate layout and installation of automatic power door operator with connections to power supplies and access-control system.

1.10 WARRANTY

- A. Automatic Door Operators to be free of defects in material and workmanship for a period of One (1) year from the date of substantial completion.
- B. During the warranty period a factory trained technician shall preform service and affect repairs. A safety inspection shall be performed after each adjustment or repair and a completed inspection form submitted to the owner.
- C. During the warranty period all warranty work shall be performed during normal working hours.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. dormakaba • Reamstown, PA • 1-844-SPEC-NOW (1-844-773-2669) • Website: www.dormakaba.us • Email: specnow@dorma.com
- B. Substitutions: Requests for substitution and product approval in compliance with the specification must be submitted in writing and in accordance with the procedures outlined in Division 1, Section "Substitution Procedures". Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 AUTOMATIC SWING DOOR OPERATOR

- A. Model: DORMA, ED Series ED250 (Basis of Design) An Integrated, self-learning automatic swing door operator with an advanced CPU, a multistage gearbox with real time adaptive software and available user interface.
 - 1. Automatic Door Configuration:
 - a. Configuration: pair of doors swinging.
 - b. Traffic Pattern: as shown on drawings

c. Mounting: Surface applied

B. Control Features

1. Power-hold Close
2. Built in Lock Delay
3. On-Off-Hold Open switch control to control door function, (Automatic-Hold Open- Exit Only)
4. On-Off Power Switch
5. Fire Alarm Integration
6. Field Adjustable Handing
7. Push and Go
8. Power Assist Opening Activation
9. Intergrated Connections for Monitored Safety Sensors and other accessories.
10. Integrated access control

C. Door Control Features

1. Wind Load and Stack Pressure microprocessor monitored with power boost to ensure secure opening and closing in changing conditions.
2. Door Weight Max. ED 250 600 lbs.

D. Header Size: Fine header height at 2 3/4" by 5" 1/8" depth.

2.3 ACTIVATION DEVICES

A. Activation Device:

1. Push Plate: Hard wired, 4-3/4 inch square stainless steel push plate engraved with "Push to Open" with a handicap logo.
2. Card reader - by others.

2.4 ELECTRICAL

A. Electrical 115 V AC +/- 10% 50/60 Hz 6.6 A max.

2.5 ALUMINUM FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Painted Finish:

1. Kynar paint finish with 20 year finish warranty by finisher, to match architects sample

PART 3 - EXECUTION

PART 4 - EXECUTION

4.1 EXAMINATION

- A. Examine doors and frames with Installer present, for compliance with requirements for installation tolerances, wall and floor construction and other conditions affecting performance of automatic entrances.
- B. Examine roughing in for electrical source power to verify actual locations of wiring connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

4.2 INSTALLATION

- A. General: Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure non-movement joints.
- B. Entrances: Install automatic entrances plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place.
 - 1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
 - 2. Set headers, carrier assemblies, tracks, operating brackets, and guides level and true to location with anchorage for permanent support.
- C. Door Operators: Connect door operators to electrical power distribution system as specified in Division 26 Sections.
- D. Sealants: Comply with requirements specified in Division 07 Section "Joint Sealants" to provide seal between the operator housing and wall surface. installation.
- E. Signage: Apply signage on both sides of each door and each sidelight as required by ANSI/BHMA A 156.19

4.3 FIELD QUALITY CONTROL

- A. Manufacturer's representative shall provide technical assistance and guidance for installation of automatic doors.

1. Factory trained and AAADM certified representative shall test and inspect each automatic door to determine compliance of the installed system to ANSI/BHMA A 156.19

4.4 ADJUSTING

- A. Adjust door operators and controls for smooth and safe operation.

4.5 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by automatic operator installation promptly after installation .

4.6 DEMONSTRATION

- A. Engage a factory authorized representative to train Owner's maintenance personnel to adjust, operate, and maintain safe operation of automatic entrances.

END OF SECTION 08 71 13

SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Windows.
 - 2. Doors.
 - 3. Glazed curtain walls.
 - 4. Glazed entrances.
 - 5. Interior borrowed lites.
 - 6. Storefront framing.
 - 7. Metal-Framed Skylights
- B. Related Requirements:
 - 1. Refer to Section 08 44 13 "Glazed Aluminum Curtain Walls," Section 08 41 13 "Aluminum-Framed Entrances and Storefronts," for requirements applicable to single subcontract responsibility for glazing.

1.2 ACTION SUBMITTALS

- A. Product Data: Submit product data for each glass product and glazing material indicated.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Samples: Label samples to indicate product, characteristics, and locations in the Work. Furnish samples of the following:
 - 1. Except for clear glass, submit samples of each glass type specified, in the form of 12 inch square Samples.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer Certificates: Submit a letter from glass manufacturer certifying that he has reviewed the glazing details proposed for the Project, including the use of gaskets and sealants, and that each product to be furnished is recommended for the application shown.
- B. Design Data: Submit the following from the glass manufacturer:

1. Thermal Stress Analysis: For each exterior glass unit type, each building elevation. The analysis shall clearly indicate all the expected service temperature ranges and the effects of partial and full shading on the glass. Append to the thermal stress analysis a statement from the glass manufacturer that based upon this analysis that the resulting thermal stresses will not reduce the specified "statistical probability of breakage."
 2. Wind Load Analysis: For each glass unit type, each building elevation. The analysis shall clearly indicate that the statistical probability of breakage at the design wind pressure will not exceed the specified statistical probability of breakage.
- C. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.
1. Material Certificates: Submit glass treatment certificates signed by manufacturer of the heat-soaked glass products certifying that products furnished comply with requirements.
- D. Product Test Reports: Submit product test reports for each type of glazing sealant and gasket indicated.
- E. Warranties: Submit special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Source Limitations for Glass and Glazing Accessories: Obtain glass and glazing accessories from one source for each product.
- C. Fire-Rated Window Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.
- D. Safety Glass: Comply with the applicable requirements of the laws, codes, ordinances and regulations of Federal and Municipal authorities having jurisdiction. Wherever requirements conflict, the more stringent shall be required. Obtain approvals from all such authorities. As a minimum, provide Category II materials complying with testing requirements in 16 CFR 1201 (Consumer Product Safety Commission "Safety Standard for Architectural Glazing Materials," as published in the Code of Federal Regulations) and ANSI Z97.1 for Category A performance.

1. Subject to compliance with requirements, permanently mark safety glass with certification label of Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction. Locate permanent markings in one corner, and in the same location, of each glass lite in accordance with the requirements of the SGCC labeling guidelines. Markings shall have a nominal size of no greater than 1-inch in diameter, and be located with glass edge clearances, at the corner, by not more than 3/4-inch up and 3/4-inch over.
- E. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 1. GANA Publications: GANA's "Glazing Manual" and "Laminated Glass Design Guide."
 2. IGM Publications: IGM TM-3000, "Vertical Glazing Guidelines."
- F. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the Insulating Glass Certification Council (IGCC) or of the Associated Laboratories, Inc. (ALI).
- G. Quality Control (Production) Testing: As a minimum, provide the following quality control (production) testing for the exterior glass units:
 1. Bow and Warp Distortion (Flatness) Tolerance Testing:
 - a. During the production of the heat-treated glass lites, measure for bow and warp in accordance with ASTM C 1048. Measure the lites on a vertical plane with an aluminum straight edge or fishing line.
 - 1) Measure the monolithic glass lites for compliance with the bow and warp tolerances under Article "Heat-Treated Float Glass," Paragraph "Flatness Tolerances," unless otherwise accepted by the Owner and Architect at the preconstruction glass mockup.
 - b. During glass production, and once an hour, randomly select a single heat-treated glass lite and measure it. Document and record results. Tag each glass lite that falls outside of the maximum bow and warp limits and certify that these non-conforming glass lites were not incorporated into the Work.
 - c. Provide written documentation of the bow and warp readings in fractions of an inch or millimeters for each tested glass lite to the Owner and Architect, if requested. Provide additional written documentation as requested by the Owner and Architect.
 2. Roll Ripple Distortion (Flatness) Tolerance Testing:

- a. During the production of the heat-treated glass lites, measure each low emissivity coated, unfritted, monolithic glass lite having a 1/4-inch- thickness or greater using a LiteSentry or Osprey Series type optical scanning measurement device complying with ASTM C 1652 for digital grid scanning glass devices. [During the production of the 100 percent full screen, frit-coated monolithic heat-treated glass lites having a 1/4-inch- thickness or greater, and at a frequency of at least once an hour, randomly select a monolithic single lite and measure it using a trolley type scanning measurement device complying with ASTM C 1651.]
 - 1) Measure the monolithic glass lites for compliance with the flatness tolerances under Article "Heat-Treated Float Glass," Paragraph "Flatness Tolerances," unless otherwise accepted by the Owner and Architect at the preconstruction glass mockup.
- b. Document and record results for each glass lite. Tag each glass lite that falls outside of the maximum flatness limits and certify that these non-conforming glass lites were not incorporated into the Work.
 - 1) Provide written documentation of the flatness readings in fractions of an inch, in millimeters, and in millidiopters, for each glass lite to the Owner and Architect, if requested. Provide additional written documentation as requested by the Owner and Architect.
3. Color Tolerance Testing: During production, test monolithic coated and coated insulating glass units for color compliance as follows:
 - a. Establish a color target selected from the accepted pre-construction glass mockup unit(s) and perform quality control color control checks using either an off-line, or on-line, spectrophotometer. Examples of acceptable off-line devices include Minolta 2500d/2600d; examples of acceptable on-line devices include Benchmodel Spectrophotometers. Color measurement shall be taken from the uncoated side.
 - b. Frequency: Test a minimum of one unit every hour.
 - c. Document and record results for each glass unit. Tag each unit of glass that falls outside of the color variation limits and certify that these non-conforming glass units will not be incorporated into the Work.
4. Insulating Glass Unit Testing Requirements: During production, test insulating glass units as follows:
 - a. Butterfly Unit Adhesion Pull Testing:
 - 1) Adhesion Criteria: Comply with the pass/fail requirements of the sealant manufacturer's published guidelines and/or sealant manufacturer's certification audit requirements/recommendations. Minimum pull back to 30 degrees from horizontal with no adhesive failure.

- 2) Frequency: Test one minimum 4-by-6-inch- size unit each eight-hour shift and after each sealant drum change.
 - 3) Test units shall be fabricated on the same production line and processing equipment and with the same spacers and sealant used in the production of the insulating glass units fabricated for the Project.
- b. Desiccant Temperature Rise Testing:
- 1) Test Criteria: Comply with the desiccant manufacturer's written recommendations.
 - 2) Frequency: Test a minimum of once every eight-hour shift and after each drum change.
- c. Bow/Warp and Air Space Measurement Concave/Convex Testing:
- 1) Measure and record bow and warp once every hour on a vertical plane with an aluminum straight edge or with a laser.
 - 2) Measure and record unit center air space a minimum of once an hour with a checking gage (FDR Designs, or equal) and visually inspect all units.
- d. Skips and voids in the primary or secondary seals are prohibited and maximum gap at primary/secondary seal interface shall be 1 inch in length and 3/32 inch in width.
- e. Document and record results. Provide additional documentation upon request by the Owner or Architect.

1.5 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. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting (using either breather or capillary tubes) and sealing.

1.6 FIELD 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.

1.7 WARRANTY

- A. Manufacturer's Special Warranty on Laminated Glass: Written warranty, made out to Owner and signed by laminated-glass manufacturer agreeing to furnish replacements for laminated-glass units that develop edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those specified within the warranty period indicated below. Upon notification of such deterioration within the warranty period, furnish replacement glass units for those glass units having edge separation, delamination, and blemishes at the convenience of the Owner.

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

- B. Manufacturer's Special Warranty on Insulating Glass: Written warranty, made out to Owner and signed by insulating-glass manufacturer agreeing to furnish replacements for insulating-glass units whose hermetic seal has failed within specified warranty period indicated below. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass. Upon notification of such deterioration within the warranty period, furnish replacement glass units for failed glass units at the convenience of the Owner.

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

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

- A. Refer to Finish Schedule on the Drawings for the extent of glass types and locations. The Contractor shall confirm the levels of heat-treatment required for each glass type scheduled as contained in "Performance Requirements" and "Quality Assurance" Articles.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Provide and install watertight and airtight glazing systems capable of withstanding thermal movement and wind and impact loads without failure of any kind, including loss or breakage of glass, failure of seal or gaskets, exudation of glazing sealants, and excessive deterioration of glazing materials.
- B. Glass Design: Glass thicknesses and heat treatments indicated are minimum requirements. Glazing details shown are for convenience of detailing only and are to be confirmed by the Contractor relative to cited standards and final framing details. Confirm glass thicknesses and heat treatments, verified by analysis, as required to meet the performance and testing requirements specified in Section 08 44 13 "Glazed Aluminum Curtain Walls,"

- C. Thermal and Optical Performance Properties: Provide insulating 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 with lites 6 mm thick and a nominal 1/2 inch wide interspace.
 2. Center-of-Glass U-Values: NFRC 100 methodology using LBL WINDOW 6.3 computer program, expressed as Btu/ sq. ft. x h x deg F.
 3. Solar Heat Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL WINDOW 6.3 computer program.
 4. Visible Reflectance (Solar Optical) Properties: Center-of-glazing values, according to NFRC 300.

2.3 PRIMARY FLOAT GLASS

- A. Float Glass: ASTM C 1036, Type I (transparent glass, flat), Quality q3 (glazing select); as indicated in schedules.
1. Ultra Clear, Low Iron Glass: Where indicated in the schedules clear, low iron glass shall mean low iron products as follows:
 - a. AGC Asahi Glass Co. Ltd.; Krystal Klear.
 - b. Guardian Industries Corp.; UltraWhite.
 - c. Pilkington North America; Optiwhite.
 - d. Vitro S.A.B. de C.V. "Starphire."
 2. In order to reduce the possibility of glass color range rejection, the supplier of float (primary) glass products shall provide glass for the entire Project from a single facility using stockpiled batch run materials from a single source for the entire Project.
 3. Float Glass Quality Imperfection Limitations: In addition to the limitations included under ASTM C 1036, all glass shall be supplied meeting the following quality standards:
 - a. Point blemishes - seeds/stones with distortion, stain spots, dirt, surface damage - shall be limited to 0.060 inch maximum separated by 12 inches minimum.
 - b. Glass scratch/rubs shall be rejected if detectable at 10 feet.
 - c. Water blow-off stains, tag residue, and handprints will not be permitted.

2.4 HEAT-TREATED FLOAT GLASS

- A. General: Heat-treat glass where the need is determined by thermal stress analyses, by wind load analyses, and where required to meet safety glazing requirements.
- B. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of installed glass unit.

- C. **Sizes and Cutting:** Prior to heat treatment, cut glass to required sizes as determined by accurate measurement of openings to be glazed, making allowance for required edge clearances. Cut and process edges in accordance with glass manufacturer's recommendations. Do not cut or treat edges in the field. Make all cuts for hardware, access, or glass-mounted trim or accessories before heat treating.
- D. **Heat-Strengthened Glass:** Provide glass complying with ASTM C 1048 Kind HS. Surface compression range shall be between 4,000 psi and 7,000 psi for 1/4 inch thick glass.
 - 1. **Heat-Strengthened Glass Quality Imperfection Limitations:** In addition to the limitations included under ASTM C 1048, all glass shall be supplied meeting the following quality standards:
 - a. Chill cracks, roller marks, and picture framing shall not be permitted.
 - b. Tracking/cloud and heat dimples shall be rejected if detectable at 10 feet.
- E. **Fully Tempered Glass:** Provide glass complying with ASTM C 1048 Kind FT and meeting the requirements of ANSI Z97.1 for Category A performance and 16 CFR 1201 for Category II performance. Surface compression shall be equal to or greater than 10,000 psi. After tempering, heat-soak 100 percent of all fabricated glass units to European Union Standard EN14179 to reduce the potential for inclusion related glass breakage. Statistical heat soaking shall not be permitted.
 - 1. **Tempered Glass Quality Imperfection Limitations:** In addition to the limitations included under ASTM C 1048, all glass shall be supplied meeting the following quality standards:
 - a. Chill cracks, roller marks, and picture framing shall not be permitted.
 - b. Tracking/cloud and heat dimples shall be rejected if detectable at 10 feet.
- F. **Flatness Tolerances:** All heat-treated glass shall be fabricated to the following flatness tolerances. Verification of compliance for overall bow and warp shall be in accordance with ASTM C 1048. Verification of compliance for flatness shall be via an optical scanning device such as LiteSentry or Osprey Series.
 - 1. **Overall Bow and Warp:** Not greater than the maximum bow and warp tolerances in any direction as listed in ASTM C 1048 Table 2. Localized warp limited to 1/32 inch in 12 inches.
 - 2. **Roll Ripple:** The deviation from flatness at any peak (peak to valley deviation) shall not exceed 0.003 inches for 6 mmthick glass in the glass center, with leading and trailing edge deviation not to exceed 0.008 inches for 6 mmthick glass.
- G. **Millidiopter Criteria:** Maximum +/- 120 millidiopters overall or the highest overall measurement from the approved visual mockup that is less than +/- 120 millidiopter overall whichever is less when viewed outdoors.

2.5 COATED FLOAT GLASS

- A. General: Provide coated glass complying with requirements indicated in this Article, under Paragraph "Insulating Glass," and in schedules.
1. Sputter-Coated Float Glass: Float glass with the coating(s) specified in schedules, deposited by magnetron sputtered vacuum deposition process after manufacture and heat treatment (if any). Pyrolytic and wet chemical deposition glass coatings will not be permitted.
 2. Coating Quality: The allowable range of defects in coatings applied to glass shall be as accepted through glass sample submissions. Installed coated glass products which are outside of the accepted sample range shall be subject to rejection by the Architect. [In order to reduce the possibility of glass rejection, the supplier of coated glass products shall provide glass coating production runs for the entire Project from a single coating facility.] All coated glass shall be provided from a single coating facility. The allowable range of defects are defined as follows:
 - a. The vision glass area is defined as the field of glass which is greater than 1 inch from the glass unit edge.
 - 1) Pinholes: At an indoor viewing distance of 10 feet for non-reflective and reflective low emissivity coatings:
 - a) Pinholes greater than 1/16 inch in diameter shall not be permitted in 80 percent of the central portion of the vision glass area and separated by greater than or equal to 12 inches. Pinholes larger than 3/32 inch are not allowed in the outer 20 percent of the perimeter vision glass area and separated by greater than or equal to 12 inches.
 - b) No more than two readily apparent blemishes are allowed in a 3 inch diameter circle and no more than five readily apparent blemishes are allowed in a 12 inch diameter circle.
 - 2) Scratches: At an indoor viewing distance of 10 feet for non-reflective and reflective low emissivity coatings, and 15 feet for reflective coatings:
 - a) Scratches are allowed in 80 percent of the central glass area if not detectable at the viewing distance, and scratches less than or equal to 1 inch are allowed in the outer 20 percent area if not detectable at the viewing distance. Concentrated scratches or abraded areas are not allowed.
 - b) Scuffs, rub marks, cup marks, or abraded areas shall not be permitted in any glass area.

- 3) Reflectance and Transmission Inspection: When viewed outdoors against a bright uniform opaque background at a distance of 10 feet for low emissivity coatings, color, reflectance and transmission will be permitted to have a slight variance subject to Architect's acceptance.
 - a) Mottling and streaking of the coating shall not be permitted.
 - b) Coating arcing will not be permitted.
 - c) Water blow-off stains will not be permitted.
 - d) Handprints will not be permitted.
 - e) Roller marks shall not be permitted.
 - f) Positive and negative air distortion shall not be permitted.
 - g) Tag residue shall not be permitted.

2.6 LAMINATED GLASS

- A. Laminated Glass: Comply with ASTM C 1172 for kinds of laminated glass indicated and other requirements specified, including those in the Glass Schedule.
- B. Interlayer: Unless indicated otherwise, provide 0.060 inch thick polyvinyl butyral (PVB) sheet or ionoplast sheet interlayer material with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.
 1. All interlayer furnished for the Project shall have been manufactured by one of the following:
 - a. Eastman Chemical Company.
 - b. Kuraray.
- C. Laminating Process: Prior to laminating, cut glass to required sizes and profiles as determined by accurate measurement of openings to be glazed, making allowance for required edge clearances. Cut and process edges in accordance with glass manufacturer's recommendations. Do not cut or treat edges in the field. Fabricate laminated glass to produce glass free of scuff vinyl markings, handprints, tag residue, and foreign substances such as lint, hair, vinyl shavings in the central glass area and the outer 20 percent area when viewed from a distance of 39 inches and 10 feet, respectively. Handprints, tag residue, scuff vinyl markings, and foreign substances must be separated by more than 12 inches if not detectable at less than the viewing distances. Delaminations, blow-ins, short interlayers, and air or gas pockets shall not be permitted in the central glass area. In the outer 20 percent area, delamination will not be permitted; blow-ins, air or gas pockets, and short interlayers shall be limited to a maximum dimension of 3/32 inch in diameter, 3/32 inch in diameter, and 1/16 inch long, respectively. Laminate units as follows:
 1. Laminate lites with interlayer in autoclave with heat plus pressure.

2.7 INSULATING GLASS

- A. Insulating-Glass Units: Preassembled units, with dehydrated entrapped air, consisting of sheets of glass hermetically sealed at all edges with a black polyisobutylene primary and a black silicone secondary elastomeric sealant. The black silicone secondary elastomeric sealant sightlines (width) shall be uniform for each insulating glass unit and, where exposed in 2, 3, and 4 sided wet glazing assemblies, sized for the highest wind pressure in the facade. The lites of glass shall be separated by dessicant containing black colored aluminum spacers. All insulating glass units shall be IGCC certified to comply with ASTM E 2190 and with requirements specified in this Article and in the Glass Schedule.
1. Provide Kind HS (heat-strengthened) float glass where needed to comply with "Performance Requirements" Article. Provide Kind FT (fully tempered) where safety glass is indicated.
- B. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated in the Glass Schedule are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.

2.8 GLAZING SEALANTS

- A. General: Provide products of type indicated, complying with the following requirements:
1. VOC Content: For architectural sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Provide structural glazing sealants and sealant primers , having not more than 100 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Sealant shall comply with the 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."
- B. Gasket, Blocking, and Spacer Wet Glazing Materials: Silicone, compatible with and adherent to each material it will be in contact with, as recommended by the manufacturer to fulfill performance requirements.
- C. Structural and Butt Glazing Sealants: Refer to Section 07 92 00 "Joint Sealants," Article "Elastomeric Joint Sealants," subparagraph "Structural Glazing."

2.9 GLAZING GASKETS

- A. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock strips, complying with ASTM C 542, black.

B. Dense Compression Gaskets:

1. Neoprene: Continuous extruded neoprene with, cross sectional profile, physical properties, and tolerances as recommended by the window and curtain wall manufacturer, and as required, to comply with the performance requirements specified and shown all in compliance with the applicable provisions of ASTM C 864, Option II. Provide injection molded corners.
2. EPDM: Continuous extruded EPDM with cross sectional profile, physical properties, and tolerances as recommended by the window and curtain wall manufacturer, and as required, to comply with the performance requirements specified and shown all in compliance with the applicable provisions of ASTM C 864, Option II. Provide injection molded corners.
3. Silicone: Continuous extruded silicone with cross sectional profile, physical properties, and tolerances as recommended by the window and curtain wall manufacturer, and as required, to comply with the performance requirements specified and shown all in compliance with the applicable provisions of ASTM C 1115, Type C. Provide injection molded corners.
4. Thermoplastic Polyolefin Rubber: Continuous extruded thermoplastic polyolefin rubber with cross sectional profile, physical properties, and tolerances as recommended by the window and curtain wall manufacturer, and as required, to comply with the performance requirements specified and shown all in compliance with the applicable provisions of ASTM C 1115. Provide injection molded corners.
5. Any material indicated above.

C. Soft Compression Gaskets: Continuous extruded expanded foam with, cross sectional profile, physical properties, and tolerances as recommended by the window and curtain wall manufacturer, and as required, to comply with the performance requirements specified and shown all in compliance with the applicable provisions of ASTM C 509, Option II, Type II; provide the following:

1. EPDM.

2.10 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, and wet glazing materials, contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Silicone complying with ASTM C 1115, blocks, 85 +/- 5 Shore A durometer hardness, 1/16 inch less than the channel width, and length based on the face area of the glass unit to be supported in accordance with GANA standards and glass manufacturer recommendations, but not less than 4 inches.

- D. Edge Blocks: Silicone complying with ASTM C 1115, blocks, 65 +/- 5 Shore A durometer hardness, minimum 4 inches long and sized to allow 1/8 inch clearance between edge of glass and block.

2.11 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

- A. Fabricate glass and other glazing products 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 standard, to comply with system performance requirements.
 - 1. Edge and Surface Conditions: Comply with the recommendations of AAMA "Structural Properties of Glass" for "clean-cut" edges, except comply with manufacturer's recommendations when they are at variance therewith.
- B. Cutting: Do not nip glass edges. Edges may be wheel cut or sawed and seamed at manufacturer's option. For glass to be cut at site, provide glass 2 inches larger than required in both dimensions, so as to facilitate cutting of clean cut edges without the necessity of seaming or nipping. Do not cut, seam, nip or abrade heat-treated glass.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine glass framing, with glazier and glass framing erector present, for compliance with the following:
 - 1. Compliance with the specified 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 stops, glazing channels, and rabbets which will be in contact with the glazing materials immediately before glazing. Loose particles present or resulting from fabrication and cleaning shall be removed by blowing out joints with oil-free compressed air, or by vacuuming joints. Remove protective coatings, oils from cutting and drilling operations, and residue on metallic surfaces with solvents that leave no residue. Do not allow solvent to air dry without wiping. Use only lint-free towels for wiping of surfaces. Wipe metal surfaces with IPA (isopropyl alcohol) unless otherwise required by compatibility and adhesion testing results.
 - 1. Prime surfaces to receive glazing compounds. When priming, comply with wet glazing manufacturer's recommendations.
- B. Inspect each glass unit immediately before installation. Do not install any units which are improperly sized or have damaged edges, scratches or abrasion or other evidence of damage. Remove labels from glass immediately after installation.
- C. Seal vent (breather or capillary) tubes in insulating glass units in accordance with the insulating glass manufacturer's written recommendations.

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.
 - 1. All glass units shall be installed in accordance with the glass manufacturer's recommendations.
- B. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, 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. Apply primers to surfaces indicated to receive glazing materials. Use primers as determined by preconstruction compatibility and adhesion testing.
- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless more stringent requirements are recommended by glass manufacturer. Place blocks to allow water passage to weep holes. Set blocks in thin course of silicone sealant.

1. For Glass Units Less Than 72 inches: Locate setting blocks at sill one-quarter of the width in from each end of the glass, unless otherwise recommended by the glass manufacturer.
 2. For Glass Units 72 inches or Greater: Locate setting blocks at sill one-eighth of the width in from each end of the glass, but not less than 6 inches, unless otherwise recommended by the glass manufacturer.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where the length plus width is larger than 50 inches 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 minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- H. Provide edge blocking to prevent glass lites from moving sideways in glazing channel, sized and located to comply with the glass manufacturer's recommendations and the requirements in referenced glazing publications.
- I. Set glass lites with uniform pattern, draw, bow, and similar characteristics, producing the greatest possible degree of uniformity in appearance on the entire exterior wall elevation.
1. Set glass units with void between edge of units and glazing channel.
 2. Orient and install insulating glass units made up with one lite of low emissivity coated glass with the uncoated glass lite on the inboard (building) side.

3.4 LOCK-STRIP GASKET GLAZING

- A. Comply with ASTM C 716 and gasket manufacturer's written instructions. Use special tool to install and remove filler strips; lubricate in accordance with manufacturer's instructions. Provide supplementary wet seal and weep system, unless otherwise indicated.

3.5 PROTECTION AND CLEANING

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.

- C. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way and from any source, including natural causes, accidents, and vandalism.
- D. 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 by glass manufacturer.

3.6 GLASS SCHEDULE

- A. As indicated on Construction Drawings

END OF SECTION 08 80 00

SECTION 08 91 19 - FIXED LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fixed extruded-aluminum louvers.
 - 2. Blank-off panels for louvers

1.2 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 axis of the blades are horizontal).
- C. Vertical Louver: Louver with vertical blades (i.e., the axis of the blades are vertical).
- D. 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.
- E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing according to AMCA 500-L.

1.3 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. Sustainable Design Submittals:
- C. 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, flashings, sealants, and other means of preventing water intrusion.
 - 2. Show mullion profiles and locations.
- D. Samples: For each type of metal finish required.

- E. Delegated-Design Submittal: For louvers indicated to comply with structural and seismic 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. 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.
- B. Sample Warranties: For manufacturer's special warranties.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2/D1.2M.
 - 2. AWS D1.3/D1.3M.
 - 3. AWS D1.6/D1.6M.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 WARRANTY

- A. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship 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.
 - 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. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain fixed 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 pressures as indicated on Drawings.
- C. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. Component Importance Factor: 1.0.
- 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, ambient; 180 deg F, material surfaces.
- F. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.
- G. Sustainable Design Requirements:
 - 1. Aluminum louvers, extrusion and sheets:
 - 2. Bituminous Paint, Finish Paint (exterior application):

2.3 FIXED EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Storm-Resistant Louver:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc.; RS-4700 or comparable product by one of the following:
 - a. Airolite Company, LLC (The).
 - b. Cesco Products; a division of MESTEK, Inc.
 - c. Nystrom, Inc.
 - d. Ruskin Company.
2. Louver Depth: 4 inches.
3. Frame and Blade Nominal Thickness: Not less than 0.060 inch for blades and 0.075 inch for frames.
4. Louver Performance Ratings:
 - a. Free Area: Not less than 8.25 sq. ft. for a 48 inch wide by 28 inch high louver
 - b. Air Performance: Not more than 0.37 in. H2O static pressure drop at 1,050-fpm free-area intake velocity and not more than 0.50 in. H2O static pressure drop at 1,357 fpm free area exhaust velocity.
 - c. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph at a core area intake of 500 fpm..
5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 LOUVER SCREENS

A. General: Provide screen at louvers indicated.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Insect screening.

B. Secure screen frames to louver frames with machine screws with heads finished to match louver, spaced a maximum of 6 inches from each corner and at 12 inches 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.
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: Aluminum, 18-by-16 mesh, 0.012-inch wire.

2.5 BLANK-OFF PANELS

- A. Uninsulated Blank-Off Panels: Metal sheet attached to back of louver.
 1. Aluminum sheet for aluminum louvers, not less than 0.050-inch nominal thickness.
 2. Panel Finish: Same finish applied to louvers.
 3. Attach blank-off panels with sheet metal screws.

2.6 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
 1. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
 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, fabricated from stainless-steel components, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing according to ASTM E 488/E 488M conducted by a qualified testing agency.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

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. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
 1. Horizontal Mullions: Provide horizontal mullions at joints where indicated.

- C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- D. 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.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches o.c., whichever is less.
 - 1. Fully Recessed Mullions: 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.
- G. Provide subsills made of same material as louvers or extended sills for recessed louvers.
- H. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.8 ALUMINUM FINISHES

- A. Finish louvers after assembly.
- B. High-Performance Organic Finish: Three -coat fluoropolymer finish complying with AAMA 2605 and 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.
 - 1. Color and Gloss: Match Architect's sample.

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 07 92 00 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 08 91 19

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BP3-Goldwalk, Promenade-
Permit and IFC

**Steamboat Base Village
Redevelopment**
Steamboat Springs, Colorado

SECTION 09 21 16.23 - GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Shaft enclosures.
 - 2. Chase enclosures.
 - 3. Stair enclosures.
 - 4. Horizontal enclosures.

1.2 ACTION SUBMITTALS

- A. Product Data: For each gypsum board shaft-wall assembly indicated.
 - 1. Submit UL Assemblies for each condition required.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."

1.3 INFORMATIONAL SUBMITTALS

- A. Fire-Test-Response Reports:
 - 1. Include data substantiating that elevator entrances and other items that penetrate each gypsum board shaft-wall assembly do not negate fire-resistance rating.
- B. Research/evaluation reports.
- C. Acoustical-test-response reports.

1.4 QUALITY ASSURANCE

- A. Single Source Responsibility: Obtain products for gypsum board shaft-wall assembly from a single manufacturer.

1.5 FIELD CONDITIONS

- A. Comply with requirements for environmental conditions, room temperatures, and ventilation specified in Section 09 29 00 "Gypsum Board."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance:
 - 1. Walls: Provide gypsum board shaft-wall assemblies engineered to withstand the following lateral design load (air pressure) and deflection limit for maximum heights of partitions required, without failing and while maintaining an airtight and smoke-tight seal.
 - a. Lateral Loading: 5 psf
 - b. Deflection Limit: L/240.
 - 2. Horizontal Duct Enclosures: Provide gypsum board shaft-wall assemblies for horizontal duct enclosures capable of spanning distances indicated within deflection limit of L/360. Design clips and runners to allow unimpeded and recurring vertical movement, as determined by structural analysis, of not less than 1/2 inch and to provide positive attachment to structure.
- B. Fire-Resistance-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory."
- C. STC-Rated Assemblies: For gypsum board shaft-wall assemblies indicated to have STC ratings, provide assembly materials and construction complying with requirements of assemblies whose STC ratings were determined according to ASTM E 90 and classified according to ASTM E 413 by a qualified independent testing agency.
 - 1. STC-Rated Assemblies: Indicated by design designations from Gypsum Association's GA-600, "Fire Resistance Design Manual."
- D. Wall materials shall comply with the 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."

2.2 MANUFACTURERS

- A. Basis-of-Design Product: The design for gypsum board shaft-wall assemblies is based on products named on Drawings by design designation of a qualified testing and inspecting agency. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
1. American Gypsum Co.
 2. CertainTeed Corporation.
 3. Georgia-Pacific Building Products.
 4. National Gypsum Company.
 5. United States Gypsum Company.

2.3 MATERIALS AND COMPONENTS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Regional Materials: Products shall be manufactured within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.
- C. General: Comply with requirements of fire-resistance-rated assemblies indicated.
1. Provide panels in maximum lengths available to eliminate or minimize end-to-end butt joints.
 2. Provide auxiliary materials complying with gypsum board shaft-wall assembly manufacturer's written recommendations.
- D. Steel Sheet Components: Metal complying with ASTM C 645 requirements.
1. Protective Coating: Manufacturer's standard corrosion-resistant zinc coating.
- E. Studs: Manufacturer's standard profile for repetitive members and corner and end members and for fire-resistance-rated assembly indicated.
- F. Track (Runner): Manufacturer's standard J-profile track with long-leg length as standard with manufacturer, but at least 2 inches, in depth matching studs.
1. Minimum Base Metal Thickness: Match stud thickness.
- G. Jamb Struts: Manufacturer's standard J-profile strut with long-leg length of 3 inches, in depth matching studs, and not less than 0.0341 inch thick.

- H. Gypsum Liner Panels: Manufacturer's proprietary liner panels in 1 inch thickness and with moisture-resistant paper faces.
- I. Gypsum Board: ASTM C 1396/C 1396M, core type as required by fire-resistance-rated assembly indicated.
 - 1. Edges: Tapered.
- J. Water-Resistant, Gypsum Backing Board: ASTM C 630/C 630M, core type as required by fire-resistance-rated assembly indicated.
- K. Impact Resistant Gypsum Board: Refer to Section 09 29 00 "Gypsum Board."
- L. Accessories: Cornerbead, edge trim, and control joints of material and shapes specified in Section 09 29 00 "Gypsum Board" that comply with gypsum board shaft-wall assembly manufacturer's written recommendations for application indicated.
- M. Gypsum Board Joint-Treatment Materials: ASTM C 475 and as specified in Section 09 29 00 "Gypsum Board."
- N. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- O. Track (Runner) Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft-wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
 - 1. Powder-Actuated Fasteners: Provide powder-actuated fasteners with capability to sustain, without failure, a load equal to 10times that imposed by shaft-wall assemblies, as determined by testing conducted by a qualified independent testing agency according to ASTM E 1190.
- P. Acoustical Sealant: As specified in Section 09 29 00 "Gypsum Board."
- Q. Sound Attenuation Blankets: ASTM C 665 for Type I, unfaced mineral-fiber-blanket insulation produced by combining thermosetting resins with mineral fibers manufactured from slag or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to which gypsum board shaft-wall assembly attaches or abuts, with Installer present, including access panel frames, and structural framing. Examine for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Sprayed Fire-Resistive Materials: Coordinate with gypsum shaft-wall assemblies so both elements of Work remain complete and undamaged.

3.3 INSTALLATION

- A. Install gypsum board shaft-wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and the following:
 - 1. ASTM C 754 for installing steel framing.
 - 2. Section 09 29 00 "Gypsum Board" for applying and finishing panels.
- B. Do not bridge building expansion joints with shaft-wall assemblies; frame both sides of joints with furring and other support.
- C. Install supplementary framing in gypsum board shaft-wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, and similar items that cannot be supported directly by shaft-wall assembly framing.
 - 1. At elevator hoistway door frames, provide jamb struts on each side of door frame.
 - 2. Where handrails directly attach to gypsum board shaft-wall assemblies, provide galvanized steel reinforcing strip with 0.0312 inch minimum thickness of base (uncoated) metal, accurately positioned and secured behind at least one face-layer panel.
- D. Integrate stair hanger rods with gypsum board shaft-wall assemblies by locating cavity of assemblies where required to enclose rods.
- E. At penetrations in shaft wall, maintain fire-resistance rating of shaft-wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

- F. Isolate gypsum finish panels from building structure to prevent cracking of finish panels while maintaining continuity of fire-rated construction.
- G. Install control joints to maintain fire-resistance rating of assemblies.
- H. Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly. Install acoustical sealant to withstand dislocation by air-pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with manufacturer's written instructions or ASTM C 919, whichever is more stringent.
- I. In elevator shafts where gypsum board shaft-wall assemblies cannot be positioned within 2 inches of the shaft face of structural beams, floor edges, and similar projections into shaft, install 1/2 or 5/8 inch thick, gypsum board cants covering tops of projections.
 - 1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches o.c. with screws fastened to shaft-wall framing.
 - 2. Where steel framing is required to support gypsum board cants, install framing at 24 inches on center and extend studs from the projection to the shaft-wall framing.
- J. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

END OF SECTION 09 21 16.23

SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes non-structural metal framing assemblies.

1.2 PRE-INSTALLATION MEETING

- A. Preconstruction Conference: Prior to start of the non-structural metal framing work, and at the Contractor's direction, meet at Project site and review the installation procedures and coordination with other work. Meeting shall include Contractor, Architect and major material manufacturer as well as the Installer and other subcontractors whose work must be coordinated with the non-structural metal framing and the gypsum wallboard work.

1.3 ACTION SUBMITTALS

- A. Product Data: Submit product data for each product indicated.

1.4 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For non-structural metal framing assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory."
- B. Sound Transmission Characteristics: For non-structural metal framing faced with gypsum wallboard materials and having STC ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by a qualified independent testing agency.
 - 1. STC-Rated Assemblies: Indicated by design designations from GA-600, "Fire Resistance Design Manual."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.6 FIELD CONDITIONS

- A. Comply with ASTM C 754 requirements or wallboard material manufacturer's written recommendations, whichever are more stringent.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. General: For fire rated assemblies, provide materials, including accessories and fasteners produced by one manufacturer, or, when products of more than one manufacturer are used in a rated system, they shall be acceptable to authorities having jurisdiction.
- B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.2 PERFORMANCE REQUIREMENTS

- A. Gypsum Board Assembly Deflections:
 - 1. Typical Walls: Wall assemblies shall be constructed for deflection not to exceed 1/240 of the wall height when subjected to a positive and negative pressure of 5 psf.
 - 2. Walls with Tile Finish: Wall assemblies to receive tile finishes shall be constructed for deflection not to exceed 1/360 of the wall height when subjected to a positive and negative pressure of 5 psf.
 - 3. Walls with Stone Tile Finish: Wall assemblies to receive stone tile finishes shall be constructed for deflection not to exceed 1/720 of the wall height when subjected to a positive and negative pressure of 5 psf. Ceilings, bulkheads, soffits, ceiling transitions, ledges, and coves shall be constructed for a deflection not to exceed 1/360 of the distance between supports.

2.3 STEEL SUSPENDED CEILING FRAMING

- A. Components, General: Provide steel framing members sized and spaced as indicated but not less than that required to comply with ASTM C 754 under the maximum deflection conditions specified under Article 'Assembly Performance Requirements.'
- B. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625 inch diameter wire, or double strand of 0.0475 inch diameter wire.
- C. Hanger Attachments to Overhead Decks: Suitable for application indicated, fabricated from corrosion-resistant materials, with eyepins, clips or other devices for attaching hangers and capable of sustaining, without failure, a load equal to 10 times that imposed by the complete ceiling system.
- D. Hangers: As follows:
 - 1. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162 inch diameter.
 - 2. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper 0.1055 inch diameter.
 - 3. Flat Hangers: Commercial-steel sheet, ASTM A 653/A 653M, G60, hot-dip galvanized.
- E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base metal thickness of 0.0538 inch, a minimum 1/2 inch wide flange, with manufacturer's standard corrosion-resistant zinc coating.
- F. Furring Channels (Furring Members): Commercial-steel sheet with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating. No equivalent coatings allowed.
 - 1. Cold Rolled Channels: 0.0538 inch bare steel thickness, with minimum 1/2 inch wide flange, 3/4 inch deep.
 - 2. Steel Studs: ASTM C 645, 0.0312 inch minimum base metal thickness and minimum depth as required to suit deflection criteria.
 - 3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
 - a. Minimum Base Metal Thickness: 0.0312 inch.
 - 4. Resilient Furring Channels: 1/2 inch deep members designed to reduce sound transmission.
- G. Grid Suspension System for Interior Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

2.4 STEEL PARTITION AND SOFFIT FRAMING

- A. General: Provide steel framing members sized and spaced as indicated but not less than that required to comply with ASTM C 754 under the maximum deflection conditions specified under Article 'Assembly Performance Requirements.'
1. In areas where top of partitions are dependent on ceiling system for lateral support, coordinate design and installation to comply with the above deflection limitation.
 2. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating. No equivalent coatings (EQ) allowed.
- B. Steel Studs and Runners: ASTM C 645, in minimum depth indicated in partition type details; one of the following:
1. Allsteel & Gypsum Products, Inc.
 2. CEMCO.
 3. Clark Dietrich.
 4. Consolidated Fabricators, Corporation.
 5. Craco Manufacturing, Inc.
 6. Custom Stud, Inc.
 7. Marino\WARE.
 8. Phillips Manufacturing Company.
 9. Quail Run Building Materials, Inc.
 10. SCAFCO Corporation.
 11. Telling Industries.
 12. The Steel Network.
 13. United Metal Products.
 14. Minimum Base Metal Thickness:
 - a. Typical: As required to comply with deflection criteria but not less than 0.0179 inch.
 - b. Partitions Supporting Wall Mounted Casework: 0.033 inch minimum thickness.
 15. Depth: As indicated.
- C. Double-Runner System: ASTM C 645 top runners, inside runner with custom fabricated flanges with depths sized to accommodate roof and floor deck live and dead load deflections but not less than 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
- D. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Products: Subject to compliance with requirements, [provide one of the following]
[available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. CEMCO; CST and SLP-TRK brand Slotted Slip Tracks, City of Industry, CA.
 - b. ClarkDietrich Building Systems; Max Trak (SLT) Slotted Deflection Track, West Chester, OH.
 - c. Metal-Lite, Inc.; Slotted Track.
 - d. The Steel Network, Inc; VertiClip SLD Series or VertiTrack VTD Series.
- E. Firestop Track: ASTM C 645 top runner with custom fabricated flanges with depths sized to accommodate roof and floor deck live and dead load deflections but not less than 2 inch deep flanges. Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 1. Products: Subject to compliance with requirements, [provide one of the following]
[available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. CEMCO; FAS Track 1000 Slotted Deflection Track, City of Industry, CA.
 - b. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
 - c. Metal-Lite, Inc.; The System.
 - d. The Steel Network, Inc.; VertiClip SLD Series or VertiTrack VTD Series.
- F. Flat Strap and Backing Plate: 36 inch wide by 6 inch high steel sheet for blocking and bracing required for the attachment of surface mounted items and accessories indicated. Locate to span a minimum of 2 studs.
 1. Minimum Base Metal Thickness: 0.0312 inch.
- G. Cold-Rolled Channel Bridging: For channel bridging for fixture attachment or lateral bracing provide 0.0538 inch bare steel thickness, with minimum 1/2 inch wide flange:
 1. Depth: 1-1/2 inches.
 2. Clip Angle: 1-1/2 by 1-1/2 inch, 0.068 inch thick, galvanized steel.
- H. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 1. Minimum Base Metal Thickness: 0.0179 inch.
 2. Depth: 7/8 inch.
- I. Resilient Furring Channels: 1/2 inch deep, steel sheet members designed to reduce sound transmission.

- J. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members securely to substrates involved; complying with the recommendations of the gypsum board manufacturers for applications indicated.

2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Isolation Strip at Exterior Walls: Adhesive-backed, closed-cell, compressible, non-extruding, sound transmission reducing, vinyl foam tape strips with approximately 10 Shore 00 hardness that allow fastener penetration without foam displacement, 0.90 inch thick, in width 1/2 inch less than window mullion width.
 - 1. Norseal V820 Series, Norseal V8229 Tape, Saint Gobain; black color.
- C. Window Mullion Fillers: Refer to Section 05 75 00 "Decorative Formed Metal."
- D. Wood Blocking and Plywood Concealed in Partition Construction: Fire retardant treated, refer to Section 06 10 00 "Rough Carpentry."
- E. Metal Post for Tube Framing at Partial Height Walls: Refer to Section 05 50 00 "Metal Fabrications."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to which non-structural metal framing attaches or abuts, installed door frames and structural framing with Installer present for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLING STEEL FRAMING, GENERAL

- A. General: Install steel framing to comply with ASTM C 754, ASTM C 840 and the gypsum board manufacturer's recommendations, where standards conflict the more stringent shall apply.

- B. Install supplementary framing, blocking, backerplates and bracing at locations in gypsum board assemblies which are indicated to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."
- C. Isolate steel framing from building structure to prevent transfer of loading imposed by structural movement.
 - 1. Isolate ceiling assemblies where they abut or are penetrated by building structure.
 - 2. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.
 - a. Use deep-leg deflection track where indicated.
 - b. Use proprietary firestop track where indicated.

3.3 INSTALLING STEEL SUSPENDED CEILING FRAMING

- A. Suspended Ceiling Framing:
 - 1. Suspend ceiling hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
 - 3. Attach hangers to structural members. Do not support ceilings from or attach hangers to permanent metal forms, steel deck tabs, steel roof decks, ducts, pipes, or conduit.
 - 4. Secure wire hangers by looping and wire-tying, to eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
 - 5. Secure rod and flat hangers to structure, including intermediate framing members, by attaching to devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
- B. Installation Tolerances: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet measured lengthwise on each member and transversely between parallel members.

- C. Wire-tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.
- D. Install suspended steel framing components in sizes and spacings indicated, but not less than that required by the referenced steel framing and installation standards unless more stringent spacings are recommended by the gypsum board manufacturer.
- E. Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

3.4 INSTALLING STEEL PARTITION AND SOFFIT FRAMING

- A. Install continuous runners (tracks) sized to match studs at floors, ceilings, and structural walls and columns where gypsum board stud assemblies abut other construction. Secure runners to substrates with fasteners spaced a maximum of 24 inches on center unless closer spacing is recommended by the framing manufacturer for the floor and ceiling construction involved. Provide fasteners at all corners and ends of runner tracks.
 - 1. Where studs are installed directly against exterior walls, install foam gasket isolation strip between studs and wall.
 - 2. Install two beads of sealant below floor tracks for acoustical and dust control.
- B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch from the plane formed by the faces of adjacent framing.
- C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings and at partial height partitions. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
 - 1. Cut studs 1/2 inch short of full height to provide perimeter relief.
 - 2. For fire-resistance-rated and STC-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
 - 3. Terminate partition framing at suspended ceilings where indicated.
 - 4. Terminate partial height partition framing as indicated.
- D. Install steel studs and furring in sizes and at spacing indicated but not less than that required by the referenced steel framing installation standard to comply with maximum deflection and minimum loading requirements specified, unless more stringent requirements are recommended by the gypsum board manufacturer:

1. Space studs 16 inches on center, unless otherwise indicated.
- E. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.
- F. Install backerplates for support of wall mounted items.
- G. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
1. Install two studs at each jamb, unless otherwise indicated. Install one additional stud no more than 6 inches from jamb studs at single doors greater than 48 inches and at all pairs of doors.
 2. Install cripple studs at head adjacent to each jamb stud. Provide runner track and typical studs above door openings with studs spaced not more than 24 inches on center.
 3. Where indicated, frame openings to receive interior aluminum frames and overhead concealed closers as follows:
 - a. By inverting the head track, and boxing the header above the closer body. Refer to special template ST-561 for LCN 2010/2030 overhead concealed closers.
 - b. By forming a box header with back-to-back studs. Refer to template no. 08279232 for Dorma RTS 88 Series overhead concealed closers.
 - c. By complying with closer manufacturer's template requirements for other overhead concealed closers.
 4. At all welded frames with fixed anchor clips secure stud reinforcing to jamb anchor clips with not less than two self tapping screws per clip.
 5. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
- H. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- I. Isolation Strip Attachment: Where partitions abut exterior wall window mullions, and partition filler panels are not indicated, adhesively attach isolation strips to window mullions. Center isolation strips on mullion to form a continuous, sound resistant and lightproof, recessed joint seal for the entire length of the interface between the partition studs and trim members and the vertical window mullions.

3.5 CLEANING AND PROTECTION

- A. Clean floors of all non-structural metal framing debris and leave broom clean. Excess material, scaffolding, tools and other equipment are to be removed upon completion of the Work.
- B. Provide final protection and maintain conditions that ensure non-structural metal framing work remains without damage or deterioration at time of Substantial Completion.

END OF SECTION 09 22 16

SECTION 09 24 00 - CEMENT PLASTERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior horizontal and nonvertical plasterwork (stucco).

B. Related Requirements:

1. Section 05 40 00 "Cold-Formed Metal Framing" for structural, load-bearing (transverse and axial) steel studs and joists that support lath and portland cement plaster.
2. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood framing and furring included in portland cement plaster assemblies.
3. Section 06 16 00 "Sheathing" for sheathing and water-resistant barriers included in portland cement plaster assemblies.
4. Section 07 21 00 "Thermal Insulation" for thermal insulations and vapor retarders included in portland cement plaster assemblies.
5. Section 09 22 16 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support lath and portland cement plaster.
6. Section 09 96 53 "Elastomeric Coatings" for field painting and primers.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.
- D. Calculations: Show calculations for metal framing demonstrating framing has achieved a minimum 1/600 at the time of plaster application.

1. If stiffness cannot be achieved before glazing units have been installed into frames, provide additional temporary bracing for plastered surfaces. Remove temporary bracing after building has been fully enclosed.
- E. Samples for Verification: For each type of factory-prepared finish coat and for each color and texture specified, 12 by 12 inches, and prepared on rigid backing.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials inside under cover, and keep them dry and protected against damage from weather, moisture, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.5 FIELD CONDITIONS

- A. Comply with ASTM C 926 requirements.
- B. Exterior Plasterwork:
 1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
 2. Apply plaster when ambient temperature is greater than 40 deg F.
 3. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.
 4. Protect contiguous work from damage by plastering operations. Do not allow runoff water from plaster to drain over glass or metal surfaces. Cover all window and door frames, sills, ledges, and pavement before starting plastering operations.
- C. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

PART 2 - PRODUCTS

2.1 METAL LATH

- A. Expanded-Metal Lath: ASTM C 847, cold-rolled carbon-steel sheet with ASTM A 653/ A 653M, G60, hot-dip galvanized-zinc coating.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Alabama Metal Industries Company; a Gibraltar Industries company.

- b. CEMCO; California Expanded Metal Products Co.
- c. ClarkDietrich Building Systems.
- d. Marino\WARE.
- e. Phillips Manufacturing Co.

- 2. Diamond-Mesh Lath: Self-furring, 3.4 lb/sq. yd..

2.2 ACCESSORIES

- A. General: Comply with ASTM C 1063, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
- B. Metal Accessories:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Alabama Metal Industries Company; a Gibraltar Industries company.
 - b. CEMCO; California Expanded Metal Products Co.
 - c. ClarkDietrich Building Systems.
 - d. Marino\WARE.
 - e. Phillips Manufacturing Co.
 - 2. Casing Beads: Fabricated from zinc; square-edged style; with expanded flanges.
 - 3. Control Joints: Fabricated from zinc; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.

2.3 MISCELLANEOUS MATERIALS

- A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
- B. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 1/2 inch long, free of contaminants, manufactured for use in cement plaster.
- C. Bonding Compound: ASTM C 932.
- D. Fasteners for Attaching Metal Lath to Substrates: ASTM C 1063.
- E. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch diameter unless otherwise indicated.

2.4 PLASTER MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I.
- B. Colorants for Job-Mixed Finish Coats: Colorfast mineral pigments that produce finish plaster color to match Architect's sample.
- C. Lime: ASTM C 206, Type S; or ASTM C 207, Type S.
- D. Sand Aggregate: ASTM C 897.
 - 1. Color for Job-Mixed Finish Coats: In color matching Architect's sample.
- E. Acrylic-Based Finish Coatings: Factory-mixed acrylic-emulsion coating systems formulated with colorfast mineral pigments and fine aggregates; for use over cement plaster base coats. Include manufacturer's recommended primers and sealing topcoats for acrylic-based finishes.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. California Stucco Products Corp.
 - b. Dryvit Systems, Inc.
 - c. El Rey Stucco Solutions; a Parex USA, Inc. brand.
 - d. Finestone, BASF Corp.
 - e. Master Wall Inc.
 - f. Omega Products International, Inc.
 - g. Senergy, BASF Corp.
 - h. Shamrock Stucco LLC.
 - i. SonoWall, BASF Corp.
 - j. Sto Corp.
 - k. Stuc-O-Flex International, Inc.
 - 2. Color: Match Architect's sample.

2.5 PLASTER MIXES

- A. General: Comply with ASTM C 926 for applications indicated.
 - 1. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed 1 lb of fiber/cu. yd. of cementitious materials.
- B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:

1. Portland Cement Mixes:
 - a. Scratch Coat: For cementitious material, mix 1 part portland cement and 0 to 3/4 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 - b. Brown Coat: For cementitious material, mix 1 part portland cement and 0 to 3/4 parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
- C. Factory-Prepared Finish-Coat Mixes: For acrylic-based finish coatings, comply with manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that surfaces are protected from direct sun, drying winds (real or artificial) and that substrates conform to ASTM C 926.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.
- B. Prepare smooth, solid substrates for plaster according to ASTM C 926.

3.3 INSTALLATION, GENERAL

- A. Fire-Resistance-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.
- B. Sound-Attenuation Blankets: Where required, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.

3.4 INSTALLING METAL LATH

- A. Metal Lath: Install according to ASTM C 1063.

1. On Solid Surfaces, Not Otherwise Furred: Install self-furring, diamond-mesh lath.

3.5 INSTALLING ACCESSORIES

- A. Install according to ASTM C 1063 and at locations indicated on Drawings.
- B. Control Joints: Locate as approved by Architect for visual effect and as follows:
 1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
 - a. Horizontal and Other Nonvertical Surfaces: 100 sq. ft..
 2. At distances between control joints of not greater than 18 feet o.c.
 3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
 4. Where control joints occur in surface of construction directly behind plaster.
 5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

3.6 PLASTER APPLICATION

- A. General: Comply with ASTM C 926.
 1. Do not deviate more than plus or minus 1/4 inch in 10 feet from a true plane in finished plaster surfaces when measured by a 10-foot straightedge placed on surface.
 2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
 3. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
- B. Ceilings; Base-Coat Mixes for Use over Metal Lath: For scratch and brown coats, for three-coat plasterwork and having 3/4-inch total thickness, as follows:
 1. Portland cement mixes.
 2. Masonry cement mixes.
 3. Portland and masonry cement mixes.
- C. Plaster Finish Coats: Apply to provide Smooth Steel Trowel finish to match Architect's sample.
- D. Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, according to manufacturer's written instructions.

- E. Concealed Exterior Plasterwork: Where plaster application is used as a base for adhered finishes, omit finish coat.
- F. Concealed Interior Plasterwork:
- Where plaster application is concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.
 - Where plaster application is concealed above suspended ceilings and in similar locations, omit finish coat.
 - Where plaster application is used as a base for adhesive application of tile and similar finishes, omit finish coat.

3.7 PLASTER REPAIRS

- A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.8 CLEANING AND PROTECTION

- A. Remove temporary protection and enclosure of other work after plastering is complete. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 09 24 00

BASE	Nominal Plaster Thickness ^A for Three- and Two-Coat Work, in. (mm)							
	Vertical				Horizontal			
	1st Coat	2nd Coat	3rd Coat ^B	Total	1st Coat	2nd Coat	3rd Coat ^B	Total
Three-coat work: ^C								
Metal plaster base	3/8 (9.5)	3/8 (9.5)	1/8 (3)	7/8 (22)	1/4 (6)	1/4 (6)	1/8 (3)	5/8 (16)
Solid plaster base								
Unit masonry	1/4 (6)	1/4 (6)	1/8 (3)	5/8 (16)	Use two-coat work			
Cast-in-place or precast concrete	1/4 (6)	1/4 (6)	1/8 (3)	5/8 (16)				3/8 (9.5), max
Metal plaster base over solid base	1/2 (12.5)	1/4 (6)	1/8 (3)	7/8 (22)	1/2 (12.5)	1/4 (6)	1/8 (3)	7/8 (22)
Two-coat work:								
Solid plaster base:								
Unit masonry	3/8 (9.5)	1/8 (3)		1/2 (12.5)				3/8 (9.5)
Cast-in-place or precast concrete	1/4 (6)	1/8 (3)		3/8 (9.5)				3/8 (9.5)

^A Exclusive of texture.

^B For solid plaster partitions, additional coats shall be applied to meet the finished thickness specified.

^C For exposed aggregate finishes, the second (brown) coat shall become the "bedding" coat and shall be of sufficient thickness to receive and hold the aggregate.

SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Exterior gypsum board for ceilings and soffits.

B. Related Requirements:

1. Section 07 92 19 "Acoustical Joint Sealants" for acoustical joint sealants installed in gypsum board assemblies.
2. Section 09 21 16.23 "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
3. Section 09 22 16 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Gypsum board, Type X.
2. Gypsum ceiling board.
3. Exterior gypsum soffit board.
4. Glass-mat gypsum sheathing board.
5. Interior trim.
6. Exterior trim.
7. Aluminum trim.
8. Joint treatment materials.
9. Laminating adhesive.
10. Sound-attenuation blankets.
11. Acoustical sealant.

B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."

1.3 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.4 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Gypsum.
 - b. Continental Building Products, LLC.
 - c. Georgia-Pacific Gypsum LLC.
 - d. National Gypsum Company.
 - e. PABCO Gypsum.
 - f. Panel Rey SA.
 - g. USG Corporation
2. Thickness: 5/8 inch.
3. Long Edges: Tapered.

B. Gypsum Ceiling Board: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Gypsum.
 - b. Continental Building Products, LLC.
 - c. Georgia-Pacific Gypsum LLC.
 - d. National Gypsum Company.
 - e. PABCO Gypsum.
 - f. USG Corporation.
2. Thickness: 1/2 inch.
3. Long Edges: Tapered.

2.4 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

A. Exterior Gypsum Soffit Board: ASTM C1396/C1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Gypsum.
 - b. Continental Building Products, LLC.
 - c. Georgia-Pacific Gypsum LLC.
 - d. PABCO Gypsum.
 - e. USG Corporation.
2. Core: 5/8 inch, Type X.

B. Glass-Mat Gypsum Sheathing Board: ASTM C1177/C1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Gypsum.
 - b. Continental Building Products, LLC.
 - c. Georgia-Pacific Gypsum LLC.
 - d. National Gypsum Company.
 - e. PABCO Gypsum.
 - f. Panel Rey SA.
 - g. USG Corporation.
 - h. .
2. Core: 5/8 inch, Type X.

2.5 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. Expansion (control) joint.
 - d. Base-of-Wall Galvanized Moisture Barrier Trim: Galvanized-steel sheet, 2 inches high.
 - 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) VersaDry, LLC.
 - b) .

B. Exterior Trim: ASTM C1047.

1. Material: Hot-dip galvanized-steel sheet, plastic, or rolled zinc.
2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ClarkDietrich.
 - b. Flannery, Inc.
 - c. Fry Reglet Corporation.
 - d. Gordon, Inc.
 - e. Pittcon Industries.
 - f. Tamlyn.
2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221, Alloy 6063-T5.
3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.6 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
 1. Interior Gypsum Board: Paper.
 2. Exterior Gypsum Soffit Board: Paper.
 3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
 5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.
- D. Joint Compound for Exterior Applications:
 1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
 2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

2.7 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
 - 1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- E. Acoustical Sealant: As specified in Section 07 92 19 "Acoustical Joint Sealants."
- F. Thermal Insulation: As specified in Section 07 21 00 "Thermal Insulation."
- G. Vapor Retarder: As specified in Section 07 26 00 "Vapor Retarders."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- 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 INSTALLATION AND FINISHING OF PANELS, GENERAL

- A. Comply with ASTM C840.

- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.
- J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Type X: Vertical surfaces unless otherwise indicated.
2. Ceiling Type: As indicated on Drawings.
3. Skim-Coated Type: As indicated on Drawings.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels 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-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying face layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

- D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.
- E. Curved Surfaces:
 - 1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch- long straight sections at ends of curves and tangent to them.
 - 2. For double-layer construction, fasten base layer to studs with screws 16 inches o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches o.c.

3.4 INSTALLATION OF EXTERIOR GYPSUM PANELS FOR CEILINGS AND SOFFITS

- A. Apply panels perpendicular to supports, with end joints staggered and located over supports.
 - 1. Install with 1/4-inch open space where panels abut other construction or structural penetrations.
 - 2. Fasten with corrosion-resistant screws.

3.5 INSTALLATION OF 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 at locations indicated on Drawings.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners unless otherwise indicated.
 - 2. LC-Bead: Use at exposed panel edges.
- D. Exterior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners.
 - 2. LC-Bead: Use at exposed panel edges.
- E. Aluminum Trim: Install in locations indicated on Drawings.

3.6 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, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: Where indicated on Drawings.
 - 3. Level 3: Where indicated on Drawings.
 - 4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
 - 5. Level 5: Where indicated on Drawings.
 - a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
- E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.

3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

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BP3-Goldwalk, Promenade-
Permit and IFC

**Steamboat Base Village
Redevelopment**
Steamboat Springs, Colorado

END OF SECTION 09 29 00

SECTION 09 61 23 - CONCRETE FLOORING TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes concrete sealing compound for the following applications:
 - 1. New and existing concrete floor to remain exposed.
- B. Related Requirements:
 - 1. Section 03 30 00 "Cast-in-Place Concrete" for curing and hardening products for new concrete Work
 - 2. Section 09 61 29 "Concrete Processing" for concrete floors scheduled to receive polished finishes.

1.2 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's specifications, VOC content, application instructions, and general recommendations. Include data substantiating that products to be furnished comply with requirements of the contract documents.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Submit manufacturer's instructions for proper maintenance materials and procedures.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Accessibility Requirements: Comply with applicable provisions of the following:
 - a. U.S. Architectural and Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities (ADAAG).
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.

- B. Manufacturer Qualifications: Provide products produced by a company that has successfully specialized in production of this type of work for not less than 5 years.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers with seals unbroken and bearing manufacturer's labels.
- B. Store materials in a clean, dry location protected from exposure to direct sunlight. In storage areas, maintain environmental conditions within range recommended in writing by manufacturer.

1.6 FIELD CONDITIONS

- A. Environmental Requirements: Do not proceed with installation until areas to receive the work have been enclosed and until temperature and relative humidity have been stabilized and will be maintained within values established by the manufacturer for optimum quality control.
- B. Environmental Limitations: Comply with coating manufacturer's written instructions for substrate temperature, ambient temperature, humidity, ventilation, and conditions affecting floor treatment application. Do not apply coating until wet work in spaces is complete and dry; and overhead work, including installation of mechanical systems, and lighting is complete.
 - 1. Apply floor coatings when substrate temperature and surrounding air temperatures are between 50 deg F and 95 deg F.
- C. Do not apply floor coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- D. Ventilation: Provide adequate ventilation to prevent accumulation of hazardous fumes, if any, during application of concrete floor sealer in enclosed spaces, and maintain ventilation until sealer has cured.

PART 2 - PRODUCTS

2.1 SEALING COMPOUND

- A. Clear, Waterborne, Membrane-Forming Sealing Compound: ASTM C 1315, Type 1, Class A or B.
 - 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. Master Builder Solutions by BASF; MasterKure HD 100WB.
 - b. Master Builder Solutions by BASF; MasterKure HD 200WB.
 - c. The Euclid Chemical Company; Diamond Clear VOX.
 - d. QC Construction Products; QC VOC 100 WB
2. VOC Content: Sealing compounds shall have a VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Sealing compounds shall comply with the 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."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for conditions affecting performance and conditions of floor treatment with requirements for maximum moisture content. Verify concrete slabs are flat, level, and dry.
 1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter for concrete: 12 percent.
 2. Verify compatibility with and suitability of substrates, including existing finishes or primers. Verify if plasticizers in existing concrete substrate will not impair bond.
 3. Perform tests recommended by manufacturer. Proceed with installation after substrates pass testing.
 4. Commence coating application after unsatisfactory conditions are corrected and surfaces are dry.
 5. Commencement of floor treatment application indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Clean substrate, removing projections and substances detrimental to the work; comply with recommendations of manufacturer for preparation procedures. Mask off or protect adjacent surfaces not scheduled to receive sealer.
- B. Concrete Substrates: Prepare and clean substrates according to manufacturer's written instructions.
 1. Clean substrates of substances that impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants. Neutralize plasticizers that cannot be removed.

2. 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.
 3. Remove incompatible primers and reprime substrate with compatible primers as required
 4. Remove laitance, glaze, curing compounds, form release agents, dust, dirt, grease, oil, and contaminants that impair bond. Remove contaminants using mechanical means.
 5. Treat nonmoving substrate cracks and control joints to prevent cracks from telegraphing (reflecting) through flooring according to manufacturer's written recommendations.
 6. Protect substrate voids and joints to prevent flooring resins from flowing into or leaking through them.
- C. Protect walls, floor openings, equipment inserts, electrical openings, door frames, and obstructions during installation. Cover floor and wall areas at mixing stations.

3.3 APPLICATION

- A. General: Comply with manufacturer's instructions, except where more stringent requirements are shown or specified, and except where Project conditions require extra precautions or provisions to ensure satisfactory performance of the Work.
- B. Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.4 CLEANING

- A. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or appropriate methods for coating. Do not scratch or damage adjacent finished surfaces.

3.5 PROTECTION

- A. Institute protective procedures and install protective materials as required to ensure that work is without damage or deterioration at substantial completion. Protect adjacent work against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.
- B. At completion of construction activities and before Substantial Completion, touch up and restore damaged or defaced coated surfaces.

END OF SECTION 09 61 23

SECTION 09 65 13 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes resilient wall base and moldings.

1.2 ACTION SUBMITTALS

- A. Product Data: Submit product data for each type of product indicated.
- B. Samples: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches long, of each resilient product color, texture, and pattern required.

1.3 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.4 FIELD CONDITIONS

- A. Maintain temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After postinstallation period, maintain temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 RESILIENT WALL BASE (RB##)

- A. Products and Manufacturers: As indicated in Finish Schedule on Drawings. Nominal thickness not less than 1/8 inch unless greater thickness is scheduled. All resilient base shall be manufactured from rubber complying with ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous). Provide all resilient wall base in continuous coils to minimize field butt joints.
- B. Provide all resilient wall bases with a coved base toe style typically; and with straight flat or toeless base style at carpet, unless otherwise indicated in Finish Schedule on Drawings.

2.2 RESILIENT MOLDING ACCESSORIES

- A. Description: Reducer strip for resilient floor covering.
- B. Material: Rubber.
- C. Profile and Dimensions: As indicated on the Drawings.

2.3 INSTALLATION MATERIALS

- A. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, 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 resilient products.
 - 2. 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 resilient products.
- B. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
 - 1. Do not install resilient products until they are the same temperature as the space where they are to be installed.

3.3 RESILIENT WALL BASE INSTALLATION

- A. Apply wall base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- B. Install wall base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
- C. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- D. Do not stretch wall base during installation.
- E. On masonry surfaces or other similar irregular substrates, fill voids along top edge of wall base with manufacturer's recommended adhesive filler material.
- F. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends. Shave back of base at points where bends occur and remove strips perpendicular to length of base that are only deep enough to produce a snug fit without removing more than half the wall base thickness.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible. Form by cutting an inverted V-shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce a snug fit to substrate.

3.4 RESILIENT ACCESSORY INSTALLATION

- A. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor coverings that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

- A. Remove adhesive and other blemishes from exposed surfaces.
- B. Perform the following operations immediately after completing resilient product installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
 - a. Do not wash surfaces until after time period recommended by manufacturer.
- 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. Use protection methods recommended in writing by manufacturer.

END OF SECTION 09 65 13

SECTION 09 65 36 - STATIC-CONTROL RESILIENT FLOORING

1.1 SUMMARY

A. Section Includes:

1. Static-control, rubber floor tile.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to static-control resilient flooring including, but not limited to, the following:
 - a. Examination and preparation of substrates to receive static-control resilient flooring.
 - b. Installation techniques required for specified products.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Product Data: For chemical-bonding compounds, indicating VOC content.
4. Laboratory Test Reports: For chemical-bonding compounds, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For flooring products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For each type of static-control resilient flooring. Include floor-covering layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

D. Samples: For each type of static-control resilient flooring and in each color, pattern, and texture required, in manufacturer's standard size, but not less than 6 by 9 inches.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in installation techniques required by manufacturer for specified static-control resilient flooring.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required for specified products.

1.7 PROJECT CONDITIONS

- A. Maintain ambient temperatures in spaces to receive static-control resilient flooring within range recommended by manufacturer for period recommended in writing before installation, during installation, and after installation.
- B. Close spaces to traffic during static-control resilient flooring installation.
- C. Close spaces to traffic for period recommended in writing by manufacturer after static-control resilient flooring installation.
- D. Install static-control resilient flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Flooring products shall comply with the 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."

2.2 STATIC-CONTROL, RUBBER FLOOR TILE SCRF01

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Flexco.
 - 2. Roppe Corporation, USA.
 - 3. Staticworx., Eclipse EC
- B. Static-Control Properties: As determined by testing identical products in accordance with test method indicated by an independent testing and inspecting agency.
 - 1. Electrical Resistance:
 - a. Material: Point-to-point and point-to-ground resistances between 1 ohms and 1000 ohms when tested in accordance with ASTM F150 ESD STM7.1.
 - b. Material in Combination with a Person: Average resistance of 35 x 10E6 ohms when tested in accordance with ESD STM97.1.
 - 2. Static Generation:
 - a. ESD STM97.2: Less than 20 V when tested at 12 percent relative humidity with static-control footwear.
 - b. AATCC TM134: Less than 20 V when tested at 20 percent relative humidity with static-control footwear.
 - 3. Static Decay: 5000 to 0 V in less than 0.25 seconds when tested in accordance with FED-STD-101C, Method 4046.1.
- C. Critical Radiant Flux: 0.45 W/sq. cm or greater when tested in accordance with ASTM E648 or NFPA 253.
- D. Composition: ASTM F1344, Class I-B (homogenous rubber, through-mottled pattern).
- E. Surface: Smooth.
- F. Thickness: 0.08 inch.
- G. Size: 24 by 24 inches.
- H. Colors and Patterns: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare substrates in accordance with manufacturer's written instructions to ensure successful installation of static-control resilient flooring and electrical continuity of floor-covering systems.
- B. Concrete Substrates: Prepare in accordance with 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 floor-covering 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 in writing by manufacturer. Proceed with installation only after substrate alkalinity is not less than 6 or more than 8 pH unless otherwise recommended in writing by flooring manufacturer.
 - 4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., 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. 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 and remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install static-control resilient flooring until it is same temperature as space where it is to be installed.
 - 1. Move static-control resilient flooring and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum substrates to be covered by static-control resilient flooring immediately before installation.

3.2 INSTALLATION, GENERAL

- A. Install static-control resilient flooring in accordance with manufacturer's written instructions.

- B. Extend grounding strips beyond perimeter of static-control resilient floor-covering surfaces to ground connections.
 - 1. For adhesively installed flooring, embed grounding strips in static-control adhesive.
- C. Scribe, cut, and fit static-control resilient flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
 - 1. Extend static-control resilient flooring below built-in items and permanent, but movable, items that allow for a flexible layout where indicated on Drawings.
- D. Extend static-control resilient flooring into toe spaces, door reveals, closets, and similar openings.
- E. Extend static-control resilient flooring to center of door openings where flooring or color transitions occur.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on static-control resilient flooring as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
- G. Adhesive Installation: Adhere static-control resilient flooring to substrates using a full spread of static-control 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.
- H. Integral-Flash-Cove Base: Cove static-control flooring 4 inches up vertical surfaces. Support static-control resilient flooring at horizontal and vertical junction with cove strip. Butt at top against cap strip.

3.3 INSTALLATION OF FLOOR TILE

- A. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so floor tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half floor tile at perimeter.
 - 1. Lay floor tiles square with room axis.
- B. Match floor tiles for color and pattern by selecting floor tiles from cartons in same sequence as manufactured and packaged if so numbered. Discard broken, cracked, chipped, or deformed floor tiles.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to test electrical resistance of static-control resilient flooring in accordance with ASTM F150 ESD STM7.1 for compliance with requirements.
 - 1. Arrange for testing after the following:
 - a. Static-control adhesives have fully cured.
 - b. Static-control resilient flooring has stabilized to ambient conditions.
 - c. Ground connections are completed.
- B. Static-control resilient flooring will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of static-control resilient flooring.
- B. Protect static-control resilient flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- C. Cover static-control resilient flooring and protect from rolling loads until Substantial Completion.

END OF SECTION 09 65 36

SECTION 09 91 23 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and field application of paint systems on the following interior substrates:
 - 1. Concrete.
 - 2. Concrete masonry units (CMU).
 - 3. Gypsum board.
 - 4. Steel.
 - 5. Galvanized metal.
 - 6. Wood and hardboard.

1.2 DEFINITIONS

- A. General: The following terms apply to this Section. Gloss level shall be determined according to ASTM D 523.
 - 1. Gloss Level 1 (Flat, or Matte): Not more than 5 units at 60 degrees and 10 units at 85 degrees.
 - 2. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees.
 - 3. Gloss Level 3 (Eggshell): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees.
 - 4. Gloss Level 4 (Satin or Low Luster): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees.
 - 5. Gloss Level 5 (Semigloss): 35 to 70 units at 60 degrees.
 - 6. Gloss Level 6 (Gloss): 70 to 85 units at 60-degrees.
 - 7. Gloss Level 7 (High Gloss): More than 85 units at 60 degrees.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat, with texture to simulate actual conditions.

1. Provide stepped Samples, defining each separate coat, including primers. Use representative colors when preparing Samples for review. Resubmit until required gloss, color, and texture are achieved.
2. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.
3. Submit paint samples on hardboard, 12 inches square, of each color and texture required.
4. Submit paint samples on zebra board, 12 inches square, to demonstrate hiding.
5. Submit paint samples on actual substrate to be painted, 12 inches square, of each color and texture required.

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. 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. Paint: 1 gal. of each material and color applied.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications 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.

1.6 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F 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 Family of Products (Benjamin Moore, Coronado, Corotech, Insl-x, LenMar)
 - 2. PPG Paints (PPG)
 - 3. Sherwin-Williams Co. (SW)
- B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles for the paint category indicated.
 - 1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers.

2.2 PAINT, GENERAL (PT##)

- A. Material Compatibility: Provide materials for use within each paint system that are compatible with one another and with the substrates indicated, under conditions of service and application, as demonstrated by manufacturer based on testing and field experience. 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: 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 content of not more than 50 g/L Nonflat Paints and Coatings: VOC content of not more than 100 g/L.
 - 2. Dry Fog Coatings: VOC content not more than 150 g/L.
 - 3. Primers, Sealers, and Undercoaters: VOC content not more than 100 g/L.
 - 4. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC content not more than 250 g/L.
 - 5. Zinc-Rich Industrial Maintenance Primers: VOC content not more than 340 g/L.
 - 6. Pre-Treatment Wash Primers: VOC content not more than 420 g/L. Floor Coatings: VOC content not more than 100 g/L.
 - 7. Shellacs, Clear: VOC content not more than 730 g/L.
 - 8. Shellacs, Pigmented: VOC content not more than 550 g/L.

- C. Low-Emitting Materials: Interior paints and coatings shall comply with the 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."
- D. VOC Content: 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: 50 g/L.
 - 2. Nonflat Paints and Coatings: 50 g/L.
 - 3. Primers, Sealers, and Undercoaters: 100 g/L.
 - 4. Rust-Preventive Coatings: 100 g/L.
 - 5. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
- E. Low-Emitting Materials: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the 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."
- F. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
- G. Colors and Gloss: As indicated in Finish Schedule on Drawings. Reference to a particular manufacturer's number or color name is used only as a convenience for the Architect in order to establish the Project color and gloss requirements. These references are not intended to describe the required generic paint systems. For generic paint system requirements, refer to the "Interior Paint Schedule" at the end of Part 3, as applicable to the respective conditions of use.
 - 1. The selection of paint colors and gloss are indicated by manufacturer and color type; designated as "PT##."
 - 2. Furnish the same lots, batches, etc. within the same contiguous areas of the building (i.e., corridors on the same floors, common rooms which adjoin each other, etc.).

2.3 PREPARATORY COATS

- A. CMU Block Filler:
 - 1. Benjamin Moore; Coronado Super Kote 5000 Latex Block Filler (958-11).
 - 2. PPG; Speedhide Interior/Exterior Masonry Latex Block Filler (6-7).
 - 3. SW; PrepRite Block Filler Interior/Exterior Latex (B25W25).

- B. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint systems indicated.
- C. Primer Sealer, Latex, Interior:
 - 1. Benjamin Moore; Ultra Spec 500 Interior Latex Primer (N534).
 - 2. PPG; Speedhide Zero Interior Latex Sealer Quick-Drying (6-4900).
 - 3. SW; ProMar 200 Zero VOC Interior Latex Primer (B28W02600).
- D. Primer, Alkali Resistant, Water Based:
 - 1. Benjamin Moore; Super Spec Masonry Int/Ext Acrylic High Build Primer (N068).
 - 2. PPG; Perma-Crete Interior/Exterior Alkali-Resistant Primer (4-603).
 - 3. SW; Loxon Concrete & Masonry Primer Interior/Exterior Latex (A24W8300).
- E. Primer, Latex, for Interior Wood:
 - 1. Benjamin Moore; Ultra Spec 500 Interior Latex Primer (N534).
 - 2. PPG; SEAL GRIP Interior Primer/Finish (17-951).
 - 3. SW; Premium Wall & Wood Interior Latex Primer (B28W08111).
- F. Where manufacturer does not recommend a separate primer formulation on substrate indicated, use paint specified for finish coat.

2.4 WATER-BASED PAINTS

- A. Latex, Interior, Gloss Level 1 (Flat):
 - 1. Benjamin Moore; Ultra Spec 500 Interior Flat (N536).
 - 2. PPG; SPEEDHIDE zero Interior Zero-VOC Latex Flat (6-4110XI).
 - 3. SW; ProMar 200 Zero VOC Interior Latex Flat (B30-2600 Series).
- B. Latex, Interior, Gloss Level 3 (Eggshell).
 - 1. Benjamin Moore; Ultra Spec 500 Interior Eggshell (N538).
 - 2. PPG; SPEEDHIDE zero Interior Zero-VOC Latex Eggshell (6-4310XI).
 - 3. SW; ProMar 200 Zero Interior VOC Latex Eg-Shel (B20-2600 Series).
- C. Latex, Interior, High Performance Architectural, Gloss Level 3 (Eggshell):
 - 1. Benjamin Moore; Corotech PreCatalyzed Waterborne Epoxy Eggshell V342.
 - 2. PPG; Pitt-Glaze WB1 Interior Eggshell Pre-Catalyzed Water-Borne Acrylic Epoxy (16-310).
 - 3. SW; Pro Industrial Pre-Catalyzed Waterbased Epoxy Eg-Shel (K45W1150 Series).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with manufacturer's requirements for paint application. Comply with procedures specified in PDCA P4.
 - 1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.

3.2 PREPARATION

- A. Remove hardware and hardware accessories, cover plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible, provide surface-applied protection before surface preparation and painting.
- B. Before applying paint or other surface treatments, clean substrates of substances that could impair bond of paints. Remove oil and grease before cleaning.
 - 1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- C. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified. Provide barrier coats over incompatible primers or remove and reprime.
 - 1. Gypsum Wallboard: Repair all surfaces in gypsum wallboard with wallboard joint finishing compound or spackling compound, filled out flush and sanded smooth. Clean all surfaces and taped joints of dust, dirt and other contaminants and be sure they are thoroughly dry before applying paint.
 - 2. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.
 - 3. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
 - 4. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.
 - a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.

- b. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.
- D. Mix and prepare paint materials according to manufacturer's written instructions.
 - 1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 - 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
 - 3. Use only thinners approved by paint manufacturer and only within recommended limits.
- E. Tint each undercoat a lighter shade to facilitate identification of each coat when multiple coats of same material are applied. Tint undercoats to match the color of the topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

- A. Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
 - 1. Paint colors, surface treatments, and finishes are indicated in Finish Schedule on Drawings.
 - 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 - 3. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 4. Extend coatings in exposed surfaces, as required, to maintain system integrity and provide desired protection.
 - a. 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.
 - 5. 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.
- B. 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.

- a. 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.
 - b. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
 - c. If undercoats, stains, 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.
2. 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. 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. 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.
- E. 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.
 - a. .
 - b. .

3.4 CLEANING

- A. At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.
- B. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

- C. After completing painting operations in each space or area, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection, if any.

3.5 PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage from paint application. Correct damage to work of other trades by cleaning, repairing or replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.6 INTERIOR PAINTING SCHEDULE

- A. Gypsum Board Substrates:
 - 1. Latex System:
 - a. Primer: Sealer, latex, interior.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior (gloss as indicated in Finish Schedule).
- B. Steel Substrates:
 - 1. High-Performance Architectural Latex System:
 - a. Primer: Acrylic.
 - b. Intermediate Coat: Latex, interior, high performance architectural; matching topcoat.
 - c. Topcoat: Latex, interior, high performance architectural (gloss as indicated in Finish Schedule).
 - 2. Semigloss Dry Fall Coating:
 - a. Primer: Interior semigloss dry fall coating.
 - b. Intermediate Coat: Interior semigloss dry fall coating.
 - c. Finish Coat: Interior semigloss dry fall coating.
- C. Steel (Factory-Primed) Substrates:
 - 1. High-Performance Architectural Latex System:
 - a. Primer: Acrylic (applied over factory primer).

- b. Intermediate Coat: Latex, interior, high performance architectural; matching topcoat.
- c. Topcoat: Latex, interior, high performance architectural (gloss as indicated in Finish Schedule).

END OF SECTION 09 91 23

SECTION 09 96 00.13 - EXTERIOR HIGH PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of high-performance coating systems on exterior substrates. The substrates include:
 - 1. Substrates:
 - a. Uncoated aluminum.
 - b. Architecturally exposed structural steel.
 - c. Galvanized steel.
 - d. Exterior and interior steel stairs and ladders.
 - e. Metal Railings.
 - f. Miscellaneous exposed flashings and trims.
- B. Related Requirements:
 - 1. Factory- or shop-applied primers applied as Work of other Sections must be coordinated with field-applied finish coats. Review other Sections for factory- or shop-primed products and reference this Section for product requirements:
 - 2. Section 05 50 00 "Metal Fabrications" for shop priming of metal substrates with primers specified in this Section.
 - 3. Section 09 91 23 "Interior Painting" for general field painting.
 - 4. Section 09 96 53 "Elastomeric Coatings" for general field painting.
 - 5. Section 05 51 00 "Metal Stairs" for shop priming of metal substrates with primers specified in this Section.
 - 6. Section 05 52 13 "Pipe and Tube Railings" for shop priming of metal substrates with primers specified in this Section.
 - 7. Section 05 73 00 "Decorative Metal Railings" for shop priming of metal substrates with primers specified in this Section.
 - 8. Section 07 62 00 "Sheet Metal Flashing and trim" for shop priming of metal substrates with primers specified in this Section.

1.2 DEFINITIONS

- A. Definitions of gloss levels below are from "MPI Architectural Painting Specification Manual" (hereafter, "MPI Manual").
 - 1. Gloss Level 1, Matte or Flat finish: 0 to 5 units at 60 degrees and maximum 10 units at 85 degrees.

2. Gloss Level 2, Velvet finish: Maximum 10 units at 60 degrees and 10 to 35 units at 85 degrees.
 3. Gloss Level 3, Eggshell finish: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees.
 4. Gloss Level 4, Satin finish: 20 to 35 units at 60 degrees and minimum 35 units at 85 degrees.
 5. Gloss Level 5, Semi-Gloss finish: 35 to 70 units at 60 degrees.
 6. Gloss Level 6, Gloss finish: 70 to 85 units at 60 degrees.
 7. Gloss Level 7, High-Gloss finish: More than 85 units at 60 degrees.
- B. Blocking: Two painted surfaces sticking together such as a painted door sticking to a painted jamb.
- C. ASTM: ASTM International develops international standards for materials, products, systems and services used in construction, manufacturing and transportation: www.astm.org.
- D. Bio-Pruf™: Anti-microbial additive that inhibits the growth of odor and stain causing mold and mildew on the paint film. "Antimicrobial" is defined as any means or mode of restricting growth or spread of microbes.
- E. CHPS: Collaborative for High Performance Schools. A national movement to improve student performance and the entire educational experience by building the best possible schools: www.chps.net.
- F. CRGI: Coatings Research Group Inc. is an international association of paint and coatings manufacturers dedicated to the benefits of shared research and development: crgiconnect.com.
- G. DTM: Direct to metal. A coating that can be applied directly to a metal surface; refer to manufacturer's product information for surface preparation and application instructions.
- H. EG: Ethylene Glycol. Ethylene glycol is listed as a hazardous air pollutant (HAP) by the U.S. EPA: www.epa.gov.
- I. EPR: Environmental Performance Rating. Master Painters Institute's formula that relates VOC, Performance of Category, Gloss and Appropriate specified use. Higher values equate to greater eco- efficiency.
- J. HAP: Hazardous Air Pollutant: According to the United States Environmental Protection Agency (EPA), Hazardous air pollutants, also known as toxic air pollutants or air toxics, are those pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects: www.epa.gov.
- K. LEED: LEED (Leadership in Energy and Environmental Design) is a voluntary, consensus-based, market- driven program that provides third-party verification of green buildings: www.usgbc.org.

- L. MPI: Master Painters Institute. An organization that establishes architectural paint standards and quality assurance programs in North America: www.paintinfo.com.
- M. NACE: National Association of Corrosion Engineers www.nace.org.
- N. PDCA: Painting & Decorating Contractors of America: www.pdca.org.
- O. RAVOC: Reactivity adjusted VOC. 'Reactivity' means the ability of a VOC to promote ozone formation.
- P. SCAQMD: South Coast Air Quality Management District is defined as most of Los Angeles, Orange, Riverside, and San Bernardino counties in California.
- Q. CARB: California Air Resources Board District is defined as the counties outside of SCAQMD.
- R. OTC: Refers to the Ozone Transmission Commission.
- S. SSPC: The Society for Protective Coatings. Surface preparation standards and specifications. www.sspc.org.
- T. ICRI: International Concrete Repair Institute. www.icri.org.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data for each type of coating system, label analysis and instructions for handling, storing, and applying each material specified. Include preparation requirements and application instructions.
 - 1. Product List: Cross reference to coating system and locations of application areas. Use same designations indicated on Drawings and in Finish Schedules. Include manufacturer's recommended spreading rate (DFT) and VOC content limits for each separate coat for each type of substrate indicated.
- B. Sustainable Design Submittals: Refer to Division 01 Section "Sustainable Design Requirements."
- C. Samples for Verification: Submit three samples for each type of coating system and each color and gloss of topcoat indicated.
 - 1. Submit Samples on rigid backing, 12 inches square.
 - a. Cured high-performance coating, 60 mils thick.
 - b. Reinforced fabric and joint cover sheet.
 - c. Ferrous and Nonferrous Metal: Provide two 4 inch square samples of flat metal and two 8 inch long samples of solid metal for each color and finish.

2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample with the following:
 - a. Paint color name and number.
 - b. Paint brand name.
 - c. "P" number if applicable, and application area.
- D. Product List: For each product indicated. Cross-reference products to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations and VOC content.

1.4 INFORMATIONAL SUBMITTALS

- A. Applicator's Project References: Submit list of completed projects.
- B. Certificate of Applicator's Supervisor: Submit certificate indicating completion of manufacturer's certified training program.

1.5 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 for single component products. All 2 component products supplied will be un-catalyzed.

1.6 QUALITY ASSURANCE

- A. Contractor shall provide verification of conformance with this specification, referenced standards and related documents. This verification to be performed by a Third Party, minimum NACE Level 1 Certified Coatings Inspector.
 1. Provide documentation verifying inspector's certification is both valid and current.
- B. Qualifications:
 1. Applicator: Use applicator experienced in the application of the specified high-performance coating for a minimum of 2 years on projects of similar size and complexity. Provide a list of completed projects including project name and location, name of Architect, name of coating manufacturer, and approximate quantity of coating applied.
 2. Applicator's Supervisor: Employ a supervisor during all phases of the work that has successfully completed manufacturer's contractor training program.
 3. Applicator's Personnel: Employ persons trained for the application of high-performance coating.

- C. Regulatory Requirements: Comply with environmental regulations.
 - 1. Air Quality Standards: Comply with the IBC and local jurisdiction for air quality regulations and chemical and heavy metal components.
 - 2. Performance and Durability:
 - a. Reflectometry.
 - b. ASTM D 4828 Standard Test Method for Practical Washability of Organic Coatings.
- D. Pre-Application Meeting:
 - 1. Convene a pre-application meeting two weeks before the start of application of the high-performance coating.
 - 2. Require attendance of parties directly affecting work of this Section, including the Contractor, subcontractor, Architect, Building Envelope Consultant, applicator and manufacturer's representative.
 - 3. Review environmental requirements, materials, and protection of adjacent work, surface preparation, application, curing, field quality control, cleaning, and coordination with other work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials in accordance with manufacturer's written instructions and acceptable ranges published in their PDS/TDS and SDS sheets.
 - 1. 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.
 - 2. Maintain containers in clean condition, free of foreign materials and residue.
 - 3. Remove rags and waste from storage areas daily.

1.8 PRE-JOB CONFERENCE

- A. A pre-job conference to review and clarify the specification is recommended.
- B. Those attending the meeting shall consist of, at minimum, Contractor, Owner (or Owner's Representative), Coatings Inspector (if applicable), and Architect.
- C. Should certified coatings inspection be required as part of the specifying documents; a pre-job conference shall become a mandatory part of the Project.
- D. Attendees of this mandatory meeting must include all parties identified above.

1.9 FIELD CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above dew point; or to damp or wet surfaces.
 - 1. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operations.
 - 2. Work may continue during inclement weather if areas and surfaces to be coated are enclosed and temperature within the area can be maintained within limits specified by manufacturer during application and drying periods.
- C. Do not apply over substrates that are frozen or contain frost.
- D. All bare/exposed steel shall be coated within 8 hours of surface preparation.
- E. Painting contractor should follow proper painting practices in accordance with SSPC-PA1 and ensure environmental conditions are within range of acceptability as documented in manufacturers Product Data Sheets/Technical Data Sheet (PDS/TDS).
- F. Should NACE Certified Coatings Inspection be part of this contract; field conditions shall be verified at the beginning of shift, and three additional times throughout the shift.

1.10 WARRANTY

- A. Provide a 20 year material warranty and 1 year labor warranty.

PART 2 - PRODUCTS

2.1 PAINT, GENERAL

- A. Material Compatibility: Systems could fail if paints used for individual coats are incompatible. Paint systems match primers and topcoats and take compatibility into consideration.
 - 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.
 - 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: Paints and coatings to be applied at Project Site shall comply with applicable VOC limits of the U.S. EPA National Emissions Standards for Architectural Coatings, exclusive of colorants added to tint bases, as calculated in accordance with 40 CFR 59 Subpart D (EPA Method 24), as follows:
1. Flat Coatings: 250 g/L.
 2. Nonflat Coatings: 380 g/L.
 3. Nonflat - High Gloss Coatings (default Nonflat): 380 g/L.
 4. Floor Coatings: 400 g/L.
 5. Industrial Maintenance Coatings: 450 g/L.
 6. Pre-Treatment Wash Primers: 780 g/L.
 7. Primers and Undercoaters: 350 g/L.
 8. Rust Preventative Coatings: 400 g/L.
 9. Waterproofing Sealers and Treatments: 600 g/L.
 10. Zinc-Rich Primers (default Industrial Maintenance): 450g/L.
 11. All Shop-Primed Metal to be coated in accordance with applicable federal, state, and local regulations.
- C. VOC Content: Paints and coatings to be applied at Project Site shall comply with applicable VOC limits of the Maricopa County Air Quality Department Rule 335 - Architectural Coatings, exclusive of colorants added to tint bases, as calculated in accordance with 40 CFR 59 Subpart D (EPA Method 24), as follows.
1. Flat Coatings: 250 g/L.
 2. Nonflat Coatings: 250 g/L.
 3. Nonflat - High Gloss Coatings (default Nonflat): 250 g/L.
 4. Floor Coatings: 250 g/L.
 5. Industrial Maintenance Primers and Topcoats: 420 g/L.
 6. Pre-Treatment Wash Primers (default Industrial Maintenance): 420 g/L.
 7. Primers, Sealers, and Undercoaters: 350 g/L.
 8. Rust Preventative Coatings (default U.S. EPA): 400 g/L.
 9. Waterproof Sealers: 400 g/L.
 10. Zinc-Rich Primers (default Industrial Maintenance): 420 g/L.
 11. All Shop-Primed Metal to be coated in accordance with applicable federal, state, and local regulations.
- D. VOC Content: Paints and coatings to be applied at Project Site shall comply with applicable VOC limits of the California Air Resources Board 2007 Suggested Control Measure for Architectural Coatings, exclusive of colorants added to tint bases, as calculated in accordance with 40 CFR 59 Subpart D (EPA Method 24), as follows:
1. Flat Coatings: 50 g/L.
 2. Nonflat Coatings: 100 g/L.
 3. Nonflat - High Gloss Coatings: 150 g/L.
 4. Floor Coatings: 100 g/L.
 5. Industrial Maintenance Coatings: 250 g/L.

6. Pre-Treatment Wash Primers: 420 g/L.
 7. Primers, Sealers, and Undercoaters: 100 g/L.
 8. Rust Preventative Coatings: 250 g/L.
 9. (Waterproofing) Concrete/Masonry Sealers: 100 g/L.
 10. Zinc-Rich Primers 340 g/L.
 11. All Shop-Primed Metal to be coated in accordance with applicable federal, state and local regulations.
- E. VOC Content: Paints and coatings to be applied at Project Site shall comply with applicable VOC limits of the South Coast Air Quality Management District Rule 1113: Architectural Coatings, exclusive of colorants added to tint bases, as calculated in accordance with 40 CFR 59 Subpart D (EPA Method 24), as follows:
1. Flat Coatings: 50 g/L.
 2. Nonflat Coatings: 50 g/L.
 3. Nonflat - High Gloss Coatings (default Nonflat): 50 g/L.
 4. Floor Coatings: 50 g/L.
 5. Industrial Maintenance (IM) Coatings: 100 g/L.
 6. Pre-Treatment Wash Primers: 420 g/L.
 7. Primers, Sealers, and Undercoaters: 100 g/L.
 8. Rust Preventative Coatings: 100 g/L.
 9. Waterproofing Concrete/Masonry Sealers: 100 g/L.
 10. Zinc-Rich IM Primers 100 g/L.
 11. All Shop-Primed Metal to be coated in accordance with applicable federal, state, and local regulations.
- F. Colorants: The use of colorants containing hazardous chemicals, such as ethylene glycol, and shall comply with the applicable VOC limits of Rule 1113, as follows:
1. Colorants for Architectural Coatings, excluding IM Coatings: 50 g/L.
- G. Colors: As indicated in a color schedule.
1. When the final color has not been selected prior to bid submittal, Contractor may need to bid additional coats when submitting their bid. The Owner should be aware that if a color is chosen following the bid process and the color is significantly different from original color, a change order for an additional finish coat might be required.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

- A. 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. Provide products of same manufacturer for each coat in a coating system.

- B. Primer: Recommended by coating manufacturer for system specified for each condition and substrate.

2.3 SOURCE QUALITY CONTROL

- A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:
 - 1. The 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 coatings 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.

2.4 MANUFACTURERS

- A. Carboline Company.
- B. International Protective Coatings; an AkzoNobel Brand.
- C. PPG Protective and Marine Coatings (PPG).
- D. Sherwin Williams Company Protective and Marine Coatings, (SW).
- E. Tnemec Company, Inc.

2.5 ALUMINUM (NOT ANODIZED OR OTHERWISE COATED)

- A. Polysiloxane over Epoxy System: SSPC-SP 16
 - 1. Primer: Epoxy for metal aluminum/MIO filled <250 g/L.
 - a. Carboline; Carbomastic 615 AL 5.0-10.0 mils (127-254 microns) DFT.
 - b. International; Intergard 251, 2-3.0 mils (50-75 microns) DFT.
 - c. PPG; PMC Amerlock 2AL Aluminum Epoxy Mastic, 4.0-8.0 mils (100-200 microns) DFT.
 - d. SW; Macropoxy 646, 5.0-7.0 mils DFT.
 - 2. Topcoat: Polysiloxane, two-component, pigmented, gloss <250 g/L.

- a. Carboline; Carboxane 2000 3.0-7.0 mils (76-178 microns) DFT.
- b. International; Interfine 878, 2.0-3.0 mils (50-75 microns) DFT.
- c. PPG; PMC PSX 700, 3.0-7.0 mils (75-175 microns) DFT.
- d. SW; Macropoxy 646, 5.0-7.0 mils DFT.

2.6 ARCHITECTURALLY EXPOSED STRUCTURAL STEEL

A. Field Applied Fluoropolymer, Pigmented:

- 1. Primer:
 - a. PPG; Coraflon, ADS Zinc Rich Epoxy, 3.0-3.0 mils (75-100 microns) DFT.
 - b. SW; Zinc-Clad III HS, B69A100-15, 3.0-5.0 mils (75-125 microns) DFT.
 - c. Tnemec; Series 90-97 Tneme-Zinc, 2.5-3.5 mils (65-90 microns) DFT.
- 2. Intermediate Coat:
 - a. PPG; Coraflon, Epoxy Intermediate Primer, ADS573/ADS574, 2.0-5.0 mils (50-125 microns) DFT.
 - b. SW; Macropoxy 646, Fast Cure Epoxy, B58 Series, 3.0-10.0 mils (125-175 microns) DFT.
 - c. Tnemec; Series 73 Endura-Shield, 2.0-5.0 mils (50-125 microns) DFT.
- 3. Topcoat: Polyurethane, two component, pigmented, semi-gloss or satin.
 - a. PPG; Coraflon ADS, 1.5-2.2 mils, DFT.
 - b. SW; Flurokem HS (Gloss B65-580, Semi-Gloss B65-570, Satin B65-560) at 2.0-3.0 mils (50-75 microns) DFT.
 - c. Tnemec; Series 1070 Fluornar, 2.0-3.0 mils (50-75 microns) DFT.

2.7 GALVANIZED STEEL

A. Polysiloxane over Epoxy System:

- 1. Primer: Epoxy for galvanized steel.
 - a. Carboline; Rustbond 1.0-2.0 (25-50 microns) DFT.
 - b. International; Intergard Interplus 251, 2-3.0 mils (50-75 microns) DFT.
 - c. PPG; PMC Amerlock 2AL Aluminum Epoxy Mastic, 4.0-8.0 mils (100-200 microns) DFT.
- 2. Topcoat: Polysiloxane, two-component, pigmented, gloss) <250 g/L.
 - a. Carboline; Carboxane 2000 3.0-7.0 mils (76-178 microns) DFT.
 - b. International; Interfine 878, 2.0-3.0 (50-75 microns) DFT.

- c. PPG; PMC PSX 700, 3.0-7.0 mils (75-175 microns) DFT.

2.8 EXTERIOR STEEL STAIRS

A. Coating System for Exterior Stairs (Regularly Used):

1. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning. Anchor profile shall be angular with a 1.5 to 2.0 mils as per ASTM D 4417, Method C or NACE Standard RP0287.
2. Coating System:
 - a. Primer: Tnemec; Series 90G-1K97 Tneme-Zinc applied at 2.5 to 3.5 dry mils.
 - b. First Coat: Tnemec; Series 66HS Hi-Build Epoxoline applied at 4.0 to 6.0 dry mils.
 - c. Second Coat: Tnemec; Series 290 CRU applied at 2.0 to 3.0 dry mils.

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. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
 1. Confirm shop applied primer is not a temporary protective primer intended for shipping purposes.
 2. Confirm primer is suitable for anticipated service conditions.
 3. Confirm primer's ability for being top coated with specified materials.
- C. Verify environmental conditions are within coating manufacturer's specified range. Environmental conditions shall be monitored at 4 points throughout each shift. Once at beginning, once at end, and two additional times in between. Recording must be taken at area where work is being performed.
- D. Each set of environmental readings shall consist of:
 1. Relative humidity.
 2. Unless otherwise stated; relative humidity must not exceed 85%.
 3. Ambient Air Temperature.
 4. Dew Point.
 5. $\Delta??$ - (+/-Difference between surface temperature and dew point) Surface must be a minimum of 5 deg F above dew point

- E. Dust levels remaining on surface shall be verified in accordance with ISO 8502-3. A dust level 3 or cleaner shall be deemed as acceptable.
- F. Surface profile shall be verified in accordance with ASTM D 4417. Surface profile ranges must be within ranges listed in manufacturers published data.
- G. Proceed with coating application only after unsatisfactory conditions have been corrected. Commencement of coating application constitutes Contractor's acceptance of substrates and conditions.
 - 1. Verify compatibility with, and suitability of, substrates, including compatibility with existing finishes or primers.
 - 2. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - 3. Coating application indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations applicable to substrates indicated. Recommendations shall be verified to meet site conditions during the preconstruction conference.
- B. Remove plates, machined surfaces, and similar items already in place and not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
 - 1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed.
- C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
- D. Remove incompatible fillers and reprime substrate with compatible primers or apply the coat as required to produce coating systems indicated.
- E. Steel Substrates:
 - 1. All oil, grease, dirt, dust and other foreign materials must be removed prior to surface preparation commencement.
- F. Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer, but not less than the following:
 - 1. Prepare surface per SSPC SP6 "Commercial Blast Cleaning" minimum. Surface profile shall be 1.0 to 1.5 mils.
 - 2. Prior to coating, solvent wipe substrate to remove dust and residual contamination.

G. Shop-Primed Steel Substrates:

1. Clean field welds, bolted connections, and abraded areas of shop paint. Paint exposed areas with the same material used for shop priming and comply with SSPC-PA 1 for touching up shop-primed surfaces.
2. Acceptable methods of cleaning shall be in accordance with manufacturer's written instructions.
3. Blast clean according to SSPC/NACE standard specified.
 - a. [SSPC-SP5/NACE No. 1, "White Metal Blast Cleaning."]
 - b. [SSPC-SP6/NACE No. 3, "Commercial Metal Blast Cleaning."]
 - c. [SSPC-SP7/NACE No. 4, "Brush-Off Blast Cleaning."]
 - d. [SSPC-SP10/NACE No. 2, "Near White Blast Cleaning."]

H. Galvanized-Metal Substrates

1. 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 coatings.
2. Blast clean new galvanized metal substrate to receive field-applied fluoropolymer coating to SSPC-SP7/NACE NO. 4, "Brush-Off Blast Cleaning," to surface profile of 1.0 to 2.0 mils. Remove all passivator residue.
3. Clean weathered galvanized metal substrate to receive field-applied fluoropolymer coating to:
 - a. SSPC-SP7/NACE No. 4. "Brush-Off Blast Cleaning,"
 - b. To a surface profile of 1.0 to 2.0 mils.

I. Aluminum Substrates: Remove loose surface oxidation with a surface solution approved by the coating manufacturer.

1. Aluminum: Solvent clean the surface with PPG Aluma-Prep 33, per SSPC SP-1, to remove any contamination that may be present.
2. Abrade substrate to obtain a surface profile of at least 1 mil to allow for a mechanical bond. Depending on the alloy, and substrate softness, prepare surface using hand sanding. Scotch-Brite pads, or hand tool cleaning per SSPC SP-2.

J. Material Preparation: Carefully mix and prepare coating materials according to manufacturer written instructions.

1. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.
2. Stir materials before applying to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into the material. Remove film and, if necessary, strain coating material before using.

3.3 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions.
 - 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 backsides 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. 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.
- C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- D. 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.
- E. Application: Apply first coat to surfaces that have been cleaned, pretreated, or prepared for coating as soon as practicable after preparation and before subsequent surface deterioration.
 - 1. The number of coats and film thickness required is the same regardless of application method.
 - 2. Minimum Coating Thickness: Apply each material no thinner than manufacturer recommended spread rate. Provide total dry film thickness of system recommended by manufacturer.
 - a. DFT ranges per coat must fall within manufacturer's recommended ranges. Measurements shall be taken in accordance with SSPC-PA2 "method for evaluating DFT."

3.4 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: The Owner reserves the right to invoke the following procedures at any time and as often as the Owner deems necessary during the period when paints are being applied.

1. The Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to the 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. The 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 the 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 to work of other trades 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.

END OF SECTION 09 96 00.13

SECTION 09 96 53 - ELASTOMERIC 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.
- B. Section 09 29 00 "Interior Painting" for general field painting.
- C. Section 09 96 00.13 "Exterior High-Performance Coatings" for exposed structural steel elements, guardrails and handrails, and any other non-factory coated metal surfaces.

1.2 SUMMARY

- A. Section includes surface preparation and application of elastomeric coatings to the following exterior substrates:
 - 1. Concrete.
 - 2. Concrete unit masonry.
 - 3. Stucco.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 2. Indicate VOC content.
- B. Samples for Verification: For each type of elastomeric coating indicated and in each color and gloss.
 - 1. Submit Samples on same type of substrate as that to receive application, 8 inches square.
 - 2. Apply coats on Samples in steps to show each separate coat, including primers and block fillers as applicable.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

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. Quantity: Furnish an additional 1 gal. of each material, color, and texture applied.

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.
 - 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 coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 90 deg F unless otherwise permitted by manufacturer's written instructions.
- B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before starting or continuing coating operation.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace elastomeric coatings that fail within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Water penetration through the coating.
 - b. Deterioration of coating beyond normal weathering.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
- B. Basis-of-Design Products: Subject to compliance with requirements, provide products indicated in Elastomeric Coating Schedule or comparable product by one of the following:
 - 1. BASF Building Systems.
 - 2. Behr Process Corporation.
 - 3. Cloverdale Paint.
 - 4. Duron, Inc.
 - 5. General Paint.
 - 6. Kelly-Moore Paint Company Inc.
 - 7. PPG Industries.
 - 8. Pratt & Lambert.
 - 9. Rodda Paint Co.
 - 10. Sherwin-Williams Company (The).
 - 11. Sto Corp.
 - 12. Textured Coatings of America, Inc.

2.2 MATERIALS

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products List."
- B. Material Compatibility:
 - 1. Materials for use within each paint system shall be 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 paint system, products shall be recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. Colors: As indicated in a color schedule .
 - 1. 100 percent of surface area will be painted with deep tones.
- D. Crack Fillers: Elastomeric coating manufacturer's recommended, factory-formulated crack fillers or sealants, including crack filler primers, compatible with substrate and other materials indicated.

- E. Primer: Elastomeric coating manufacturer's recommended, factory-formulated, alkali-resistant primer compatible with substrate and other materials indicated.
- F. Concrete Unit Masonry Block Filler: Elastomeric coating manufacturer's recommended, factory-formulated, high-performance latex block filler compatible with substrate and other materials indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with manufacturer's requirements for maximum moisture content, alkalinity, and other conditions affecting performance of work.
- B. Begin coating only when moisture content of substrate is 12 percent or less when measured with an electronic moisture meter.
- C. Begin coating no sooner than 28 days after substrate is constructed and is visually dry on both sides.
- D. Verify that substrate is within the range of alkalinity recommended by manufacturer.
- E. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- F. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in the "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.
- B. Remove hardware and hardware accessories, plates, machined surfaces, light fixtures, and similar items already installed that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
 - 1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

- C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 - 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.
 - 2. Perform cleaning and coating application so dust and other contaminants from cleaning process will not fall on wet, newly coated surfaces.
- D. Crack Repair: Fill cracks according to manufacturer's written instructions before coating surfaces.

3.3 APPLICATION

- A. Apply elastomeric coatings according to manufacturer's written instructions.
 - 1. Use equipment and techniques best suited for substrate and type of material being applied.
 - 2. Coat surfaces behind movable items the same as similar exposed surfaces.
 - 3. Apply each coat separately according to manufacturer's written instructions.
- B. Primers: Apply at a rate to ensure complete coverage.
- C. Block Fillers: Apply at a rate to ensure complete coverage with pores filled.
- D. Elastomeric Finish Coat(s): Minimum two coats with a total dry film thickness of 16 to 18 mils .
- 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 similar to color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- F. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform finish, color, and appearance.
- G. Apply coatings 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.
- H. Apply coatings to prepared surfaces as soon as practicable after preparation and before subsequent surface soiling or deterioration.
- I. Spray Application: Use spray equipment for application only when permitted by authorities having jurisdiction. Wherever spray application is used, do not double back with spray equipment to build up film thickness of two coats in one pass.

3.4 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following testing procedures:
1. Owner will engage the services of a qualified testing agency to sample 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 materials with product requirements.
 3. Owner may direct Contractor to stop coating application if test results show materials being used do not comply with requirements. Remove noncomplying materials from Project site, pay for testing, and recoat surfaces that were coated with rejected materials. Remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.
- B. Field Testing and Inspection: Owner reserves the right to engage the services of a qualified testing agency to verify installed thickness of elastomeric coatings.

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 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, touch up and restore damaged or defaced coated surfaces.

3.6 ELASTOMERIC COATING SCHEDULE

- A. Concrete Substrates:
1. Elastomeric Coating System MPI EXT 3.1F:
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Elastomeric, pigmented, exterior, water-based, flat coating; MPI #113.
 - d. Topcoat: Elastomeric, pigmented, exterior, water-based, nonflat coating; MPI #38.
- B. Concrete Unit Masonry Substrates:

1. Elastomeric Coating System MPI EXT 4.2D:

- a. Prime Coat: As recommended in writing by topcoat manufacturer.
- b. Block Filler: As recommended in writing by topcoat manufacturer.
- c. Intermediate Coat: As recommended in writing by topcoat manufacturer.
- d. Topcoat: Elastomeric, pigmented, exterior, water-based, flat coating; MPI #113.

C. Stucco Substrates:

1. Elastomeric Coating System MPI EXT 9.1C:

- a. Prime Coat: As recommended in writing by topcoat manufacturer.
- b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
- c. Topcoat: Elastomeric, pigmented, exterior, water-based, flat coating; MPI #113.
- d. Topcoat: Elastomeric, pigmented, exterior, water-based, nonflat coating; MPI #38.

END OF SECTION 09 96 53

SECTION 09 97 26 - CEMENTITIOUS 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 cementitious coating systems on the following substrates:
 - 1. Exterior concrete.
 - 2. Exterior concrete masonry units.
 - 3. brick.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Samples for Verification: In each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, not less than 8 inches square.
 - 2. Apply coats on Samples in steps 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 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each cementitious coating, from manufacturer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency or performed by a qualified testing agency, for each product formulation.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in manufacturer's original, new, unopened packages and containers bearing manufacturer's name and label, and the following information:
 - 1. Product name or title of material.
 - 2. Manufacturer's stock number and date of manufacture.
 - 3. Contents by volume, for pigment and vehicle constituents.
 - 4. Application instructions.
 - 5. Color name and number.
 - 6. Handling instructions and precautions.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage of coatings in a clean condition, free of foreign materials and residue.
 - 1. Protect cementitious coating materials from freezing. Keep materials dry and storage area neat and orderly. Remove waste daily. Take necessary measures to ensure that workers and work areas are protected from health hazards resulting from handling, mixing, and applying the coating.

1.6 FIELD CONDITIONS

- A. Apply coatings only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F 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 the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
- B. Basis-of-Design Products: Subject to compliance with requirements, provide products indicated in Cementitious Coating Schedule or comparable product by one of the following:
 - 1. BASF Corporation-Construction Systems.
 - 2. Bonsal American, an Oldcastle company.
 - 3. Euclid Chemical Company (The); an RPM company.

4. Fox Industries, Inc.
5. Gemite Products Inc.
6. Silpro Corporation.

- C. Source Limitations: Obtain cementitious coating materials from single source and from single manufacturer.

2.2 CEMENTITIOUS COATINGS

- A. Polymer-Modified Cementitious Coating: Containing portland cement, polymer, and hydrated lime or aggregates.
1. Compressive Strength: Not less than 3500 psi at 28 days according to ASTM C109/C109M.
 2. Tensile Strength: Not less than 350 psi at 28 days according to ASTM C109/C109M.
- B. Colors: Match Architect's samples.
- C. Other Materials: Provide crack fillers, block fillers, and related materials that are compatible with cementitious finish-coat materials and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Verify suitability of substrates, including surface conditions and compatibility.
- 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 for mixing and preparing materials and as applicable to substrates indicated.

- B. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
 - 1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, incompatible coatings, and loose substrate materials.
- D. Cementitious and Masonry Surfaces: 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.
- E. Crack Repair: Fill cracks according to manufacturer's written instructions before coating surfaces.
 - 1. Cracks Larger Than 1/32 Inch: Cut out static cracks, voids, or honeycombing larger than 1/32 inch and patch with materials recommended in writing by coating manufacturer. Identify dynamic cracks and treat according to manufacturer's written instructions before beginning application.

3.3 APPLICATION

- A. Apply coatings according to manufacturer's written instructions. Use applicators and techniques suited for coating and substrate indicated.
 - 1. Dampen substrate of surfaces to receive cementitious coatings one hour before beginning application to prevent surface drag. Immediately before applying coatings, redampen substrate. Substrates shall be saturated and surface dry at time of application.
 - 2. Brushes: Use Tampico or masonry brushes best suited for material being applied.
 - 3. Spray Equipment: Use spray equipment recommended in writing by manufacturer for material and texture required.
- B. Apply coating to achieve material thickness as recommended in writing by manufacturer, but not less than the following:
 - 1. First Coat: Apply polymer-modified cementitious coating material at the rate of 2 lb/sq. yd. to achieve a total cured thickness of 25 mils.
 - 2. Second Coat: Apply polymer-modified cementitious coating material at the rate of 1 lb/sq. yd. to achieve a total cured thickness of 15 mils.
 - 3. Apply additional coats when undercoats or other conditions show through final coat until cured film is of uniform coating finish, color, and appearance.

- C. On previously coated surfaces, apply coating to achieve material thickness as recommended in writing by manufacturer, but not less than the following:
 - 1. Apply polymer-modified cementitious coating material at the rate of 1 lb/sq. yd. to achieve a total cured thickness of 15 mils.
 - 2. Apply additional coats when undercoats or other conditions show through final coat until cured film is of uniform coating finish, color, and appearance.
- D. Brush Application: Brush out and work brush coats into surfaces in an even film, filling all pores and voids at rate recommended in writing by manufacturer to achieve cured material thickness indicated. Finish coat with smooth, horizontal strokes.
- E. Spray Application: Apply each coat according to manufacturer's written instructions to provide the equivalent hiding of brush-applied coats. Follow spray application with a general light brooming of coated surface to impart a slight texture.

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 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 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 coated surfaces.

END OF SECTION 09 97 26

SECTION 103000 – EXTERIOR FIRE PITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Work includes the following fire feature elements as detailed on the Drawings.
 - 1. Custom Fire Pit
 - 2. Fire Bowls
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for concrete footings.
 - 2. Section 321400 "Unit Paving" for concrete unit pavers.

1.3 QUALITY ASSURANCE

- A. Quality Standards:
 - 1. International Building Code, IBC-2018
 - 2. NFI and National Fuel Gas Code, ANSI Z223.1/NFPA 54 or International Fuel Gas Code, latest editions.
 - 3. The National Electrical Code, ANS/NFPA 70

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Fire pit insert and accessories.
 - 2. Paint products.
- B. Samples: For each exposed product and for each color and texture specified.

- 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, supports, footings, piping and controls for custom fire pit.

1.5 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."

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of concrete foundation and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 FIRE ELEMENTS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following for the custom fire pit:
1. Manufacturer: Hearth Product Controls:
 - a. Model: PENTA54EI-NG/120VAC (48" diameter burner in 54" diameter round flat insert with electronic ignition control; natural gas source; #304 Stainless Steel, 18-gauge. Burns at 400k BTU.)
 - b. Emergency shut-off: Commercial emergency stop 311-ESTOP-3
 - c. Electronic timer: 694 NEMA, 2-hour timer
 - d. All other Misc. Appurtenances and accessories including but not limited to, conduit, gas line connections, electrical control / junction box (waterproof), and burner controls to ensure properly installed and functioning feature per manufacturer recommendation.
 2. Miscellaneous components for custom fire pit
 - a. Contractor is responsible for coordination of adjacent components of electronic ignition systems and gas shut-off valves and associated equipment, to be coordinated with Landscape Architect prior to installation.
 - b. Custom metal fire cauldron and supports.
 - c. Custom metal logs, randomly arranged to fill the bowl area. Affix all logs to baseplate.
 - d. Metal support angles in sizes as indicated on Drawings: ASTM A 36/A 36M.

- e. Perforated Metal Screen to hold the rock: Galvanized-steel sheet, ASTM A 653/A 653M, G90 coating, commercial steel Type B, 0.064 inch thick, with 1/8-by-1-inch round end slotted holes in staggered rows.
- f. Rolled Lava Stone: Black, Model 857S, 2-inches thick minimum to cover burner bar.
- g. Weep hole as indicated.
- h. Fire Pit Rules sign: Fabricate sign as indicated on Drawings.

- B. Fire Bowl
 - 1. Manufacturer and model information provided by owner.
 - 2. Burner up to 140k BTU.

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. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- D. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

2.3 FASTENERS

- A. Steel Anchor Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A with hex nuts, ASTM A 563; and, where indicated, flat washers.
- B. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
- C. 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.

2.4 MISCELLANEOUS MATERIALS

- A. 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. Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- C. 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.
- D. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

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 unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- 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.

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.

2.7 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.

2.8 STEEL FINISHES

- A. Shop prime 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 unless indicated.
- B. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" requirements indicated below:
 - 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."
- C. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.9 PAINT PRODUCTS, 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. For each coat in a paint system, provide products recommended in writing by topcoat manufacturer for use in paint system and on substrate indicated.

B. Colors: As selected by Architect from manufacturer's full range.

2.10 FINISH COATINGS

- A. Exterior Latex Paint, Flat: Water-based, pigmented coating; formulated for alkali, mold, microbial, and water resistance and for use on exterior surfaces, such as portland cement plaster, concrete, and primed wood.
- B. Exterior, Water-Based, Light Industrial Coating, Low Sheen: Corrosion-resistant, water-based, pigmented, emulsion coating formulated for resistance to blocking (sticking of two painted surfaces), water, alkalis, moderate abrasion, and mild chemical exposure and for use on exterior, primed, wood and metal surfaces.
 1. Gloss and Sheen Level: Manufacturer's standard low-sheen finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine area and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, 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. Install per Manufacturer's written recommendations, as indicated on approved Shop Drawings and in accordance with all applicable local Codes.
 1. Fire features shall include all required equipment to provide complete, in-place system including but not limited to: regulators, shut-off valves, controls and burners.
- B. Test and adjust controls, shutoffs and other safeties. Replace damaged and malfunctioning controls and equipment.
- C. Engage an authorized Manufacturer's representative to train Owner's personnel to adjust, operate, and maintain burners.

- D. 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.
- E. 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.
- F. 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.
- G. Corrosion Protection: Coat concealed surfaces of metal that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Steel: Heavy coat of bituminous paint.

3.3 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. 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.

3.4 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 dry film thickness.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 103000

SECTION 13 10 61 - ICE RINK REFRIGERATION AND PIPING

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This Section of the Contract includes all Ice Rink Equipment work called for or implied by the drawings and specification, together with all necessary incidentals whether referred to or not, as will be required to complete the work to the full intent and meaning of the drawings and specifications. The specification and drawings describe a complete and operational ice skating rink to be constructed as part of a performance based design-build contract. The work includes but is not limited to the following:
1. A central ice chiller plant will serve the ice sheet. The central plant will consist of one flooded evaporator (100 tons) and one dedicated ice system air-cooled condenser (100 tons). The evaporator and condenser are to be supplied by two (2) nominal 50-ton reciprocating compressors. The ice sheet will be served by a dedicated pumped glycol loop including a primary glycol pump and 100% backup glycol pump.
 2. R-438a refrigerant.
 3. Glycol solution consisting of 40% ethylene glycol.
 4. All inter-connecting refrigerant piping.
 5. Refrigerant charge and oil charge.
 6. Glycol Pumps (1-100% standby).
 7. Glycol mains and rink piping, including rink pipe supporting spacers, and 1½" polyethylene pipe on the main ice sheet.
 8. Glycol balance tank.
 9. Supply and installation of reinforced 5" thick (6,000 PSI) concrete rink slab with expansion joint, pipe chairs and wire mesh.
 10. Equipment house keeping pads.
 11. Insulation of cold glycol piping and refrigerant piping.
 12. Cutting and patching and sleeving by this Contractor for all refrigerant and glycol piping.
 13. Power and control wiring for all refrigeration equipment specified hereunder.
 14. Grouting of all equipment.
 15. Painting and Identification.
 16. Start-up and testing.
 17. Training.
 18. Instruction and operating manuals and as-built drawings (6 copies).
 19. Floor inserts.
 20. Refer to architectural drawings for required insulation below refrigerated slab.
 21. Underslab infrared temperature sensors.
 22. DDC Control System.
 23. Fire stopping.
 24. Zamboni snow melt pit heating coil and associated piping for Zamboni pit snow melt.

- 25. Vent box and vents for ice sheet.
- 26. Floor painting.

1.2 QUALIFICATIONS FOR REFRIGERATION INSTALLER

- A. Refrigeration Installer shall have installed a minimum of 5 artificial outdoor ice rinks using R-438a refrigerant and glycol within previous 10 years to be eligible to submit a bid on this work.
- B. The Refrigeration Installer shall have adequate personnel and equipment, and shall be approved by the Architect and Engineer.
- C. The Refrigeration Installer shall be able to satisfactorily service the equipment after installation, and shall provide 24 hour service for 1 year after acceptance of system by Owner.
- D. The Refrigeration Installer shall employ only skilled welders, each holding a currently active certificate, dated within 12 months, from a recognized testing association, indicating satisfactory welding test results per the American Welding or ASME Boiler and Unfired Pressure Vessel Code, Section IX, Welding Qualifications. Retest is required if welder has not performed welding for a period of 90 days.
- E. The refrigeration installer shall employ licensed electricians for electrical equipment installation and power wiring.
- F. The Refrigeration Installer shall provide all product data, shop drawings, designs, daily logs, record documents and warranties. The Refrigeration Installer shall furnish, install and design a complete system including all engineering, shop drawings, submittals and design work, calculations, etc. All work (e.g. shop drawings, engineering, calculations, design work, etc.) to the extent required by applicable law, shall bear the seal of an engineer properly registered in the State of Colorado. The Refrigeration Installer shall perform all work to obtain approval and permits of the ice floor system design and installed work from the local and State governing authorities and shall abide by all code requirements. The Refrigeration Installer shall include costs to pay for permits as necessary.
- G. Arena Products and Services, CIMCO Refrigeration, and Ice Builders are approved to provide proposals for this project.

1.3 RELATED WORK GENERAL

- A. The Ice Rink Contractor shall coordinate all phases of the above Scope of Work with the General Contractor, Electrical and Mechanical Contractors.
- B. The installation of all electrical work shall conform to the base building Division 26 Electrical specification.

- C. Work installed and coordinated by the ice refrigeration contractor shall include the following sections:

Section 13 10 62 - Rink Floor
Section 13 10 63 - Ice Rink Insulation
Section 13 10 64 - Ice Maintenance Equipment

1.4 RELATED WORK

- A. Work by Other Subcontractor(s):
1. Ice melt & snow melt pit and all materials, equipment and accessories not spelled out herein.
 2. Temporary lighting and heating will be provided. Should the Ice Rink Contractor require additional light or heat, he shall provide same in order to complete his work.
 3. 1-1/2 inch cold water service to Mechanical Room.
 4. Floor drains in mechanical room.
 5. 600 amp 480 V, 3-phase, 60 HZ electric service with electric disconnect switch for main power. A separate 120V electric service for controls. Electric feed to ice chiller distribution panels by Division 26.
 6. 120V temporary power in equipment room for test and lighting purposes.
 7. Perimeter rail system & inserts (supply or install).
 8. Snowmelt heating coil supply.
 9. Domestic hot and cold water supply.

1.5 CUTTING AND PATCHING

- A. Cutting and patching shall be avoided as far as possible by furnishing and insertion of sleeves and thimbles in slabs, walls, etc., as they are being built, and instructions to Contractors, leaving openings and chases for accommodation of pipes.
- B. When cutting cannot be avoided, it shall be done carefully so as not to injure the structure, and as little material as possible shall be removed. In no case shall reinforcing or structural steel be cut without the specific permission of the Architect. Openings in precast slabs shall be sleeves or precast.
- C. In case of careless or incompetent work, right is reserved to have cutting and patching done by others, and costs of same charged against the Refrigeration Installer.
- D. Refrigeration Installer shall do necessary cutting and patching for installation of his work. Surfaces shall be restored to original finish.

1.6 REFERENCED STANDARDS

- A. ANSI/ASHRAE 15 Safety Code for Mechanical Refrigeration. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. All State and local code compliance to the current edition.

1.7 SHOP DRAWINGS

- A. Provide 6 copies of shop drawings for the entire ice system. Shop drawings shall include all equipment specifications, ice floor layout, piping layout, piping schematic flow diagrams, motor control centers, electrical power diagrams, control diagrams and wiring and details of construction. Complete shop drawings shall be provided. No part of ice system will be released for construction until entire submittal is accepted by Engineer.

1.8 WARRANTY

- A. The contractor shall warranty all parts and labor of the ice rink system for a period after the acceptance of the Owner and when they have assumed operation of the facility. Warranty on equipment shall be in effect for the duration of the time offered by the manufacturer of the equipment. The chiller package shall have full 2 year warranty. The concrete floor shall have a warranty for 2 years.
- B. The Refrigeration and Rink Piping Installer guarantees that he shall repair, replace, and install any or all parts, materials, or workmanship found to be defective or lacking in specified capacity as stipulated in foregoing specifications and/or shown on drawings. Guarantee includes necessary labor, as well as material and refrigerant required for repair, replacement, and/or 24 hour per day service for a year referred to above.

PART 2 - EQUIPMENT

2.1 GENERAL

- A. Manufacturers and equipment specified below are for the purpose of setting a minimum standard of capacity and quality of equipment for the performance of the ice rink system.
- B. Provide a complete and automatic flooded R-438a and 40% ethylene glycol refrigeration system capable of producing and maintaining ice conditions from November 1st to April 1st (ski season) under the following specified design criteria.
 - 1. Refrigeration Capacity of the system is a total of 100 tons. 5°F Sat. Evap. Temp. and 105°F Cond. Temp.

2. Condenser Ambient:
 - a. Dry Bulb: 63 °F
3. Number of Evaporators: 1 at 100 tons
4. Number of Condensers: 1 at 100 tons plus heat recovery condensers
5. Number of Compressors: 2 at 50 nominal tons each
6. Electrical Supply (Power): 480V/3Ph/60 HZ.
7. (Control) 120V/1Ph/60 HZ.
 - a. All equipment shall be mechanically braced for an available fault of no less than 65,000 amps.

2.2 GLYCOL CHILLERS

- A. Flooded chiller shall be two parts all steel shell and tube type construction arranged for R-438a operation.
- B. Design flow is approximately 850 gpm per chiller for 40% ethylene glycol to maintain fluid delivery temperature to the ice of 16°F with a 10°F evaporator temperature, approximately 3°F temperature difference and a capacity of approximately 100 tons.
- C. Chiller to be constructed to ASME code and registered by the National Board for 300 psi working pressure.
- D. Chiller to be equipped with dual pressure relief valves and bulls-eye (reflex type) sight glasses (min. 2) to establish operating level of refrigerant.
- E. Chiller and surge drum to be factory insulated with 2" of foamed in place urethane insulation covered with a PVC or fiberglass jacket to protect against damage. Head covers (insulated) shall be removable without damage.

2.3 COMPRESSORS

- A. Reciprocating Compressor:
 1. Compressor shall be of the heavy-duty, reciprocating, multi-cylinder open type design, and shall be capable of withstanding 250 psi pressure differential. Compressor shall have internal relief valve, double bellows shaft seal; double tapered, roller main shaft bearings; tri-Micro oil filter and oil strainer to remove 95% of contaminants as small as 3 microns in size; dynamic and statically balanced heavy-duty crankshaft of ductile iron, shot peened; spring loaded safety heads, die-forged steel connecting rods with replaceable bearing halves; aluminum type ring; piston operated suction valve lifters to unload the compressor for starting and to provide cylinder unloading capacity control. The piston

and connecting rod shall be assembled with a shrink-fit wrist pin for higher load carrying capacities and superior wearing qualities.

2. The compressor shall be equipped with the following equipment: Crankcase oil thermometer; Crankcase heater; Oil pressure filter gauge with manual three-way valve; Oil pressure failure switch; Dual pressure switch; Unloader solenoids for 33 and 60% capacity reduction; 100% unloaded start; Built-in safety relief valve; Suction and discharge service valves; Water cooled heads and oil cooler with water solenoid and water regulating valves.
3. Provide 3/4" supply from cold glycol supply to each oil cooler then to compressor head. Provide 3/4" return from each compressor to return main.
4. Each compressor shall be direct drive by high efficiency open-drip-proof motor for part winding start 480/3/60 motor rated. Motor shall have 1.15 service factor. Compressor to be isolated from floor via isolation on skid framing.
5. Each compressor shall have a capacity for operating at 5°F. suction, and 105°F. condensing temperature.
6. Compressors shall be Vilter, Mycom or equal.
7. Provide 2 year manufacturer's warranty on chillers from time of first start-up.
8. Provide factory start-up and adjustment, which shall be approved by the Engineer.

2.4 OIL SEPARATOR/RESERVOIR

- A. The oil separator/reservoir will be a horizontal, three stage unit with integral sump. A coalescent separator element is provided for final gas/oil separation.

2.5 OIL RECEIVER

- A. Supply and install Oil Receiver complete with dual relief valve assembly and stop valves. Heater designed for 300 psig.

2.6 REFRIGERANT PIPING

- A. All refrigerant piping shall conform to the ASME B31.5 Refrigeration Pressure piping code and the ASHRAE/ANSI 15 Safety Code for Mechanical Refrigeration.

2.7 REFRIGERANT VALVES AND CONTROLS

- A. Supply and install all refrigerant stop and control valves as required. Valves to be Henry, Hubbel, Phillips, Hansen or approved equal. Supply and install two replaceable core driers complete with additional replacement cores and valves.

2.8 GAUGES AND THERMOMETERS

- A. Supply and install min. 3½” diameter gauges, Marsh or equal complete with gauge stop valves and constructed of material compatible with fluid being measured.
- B. Thermometers shall be Terrice 9” stem or equal and complete with thermometer wells.

2.9 GLYCOL VALVES AND FLEXIBLE CONNECTORS

- A. Supply and install all cold glycol valves as shown on the drawings. Valves shall be lug type butterfly, Keystone or approved equal. All valves 10” and larger shall have worm gear operators.
- B. Provide flexible connectors at the chillers and pumps.

2.10 GLYCOL EXPANSION TANKS

- A. Provide and install expansion tanks to allow for expansion and contraction of the glycol charge. Tanks to be bladder type.

2.11 GLYCOL CHILLER REFRIGERANT CONTROLS

- A. The chiller is to be complete with a float switch and isolating valves to protect the compressors against high liquid levels in the chiller. Chiller to also be complete with oil return system. Provide appropriate pressure regulating valves.
- B. High pressure liquid feeding the chiller shall be controlled using a Phillips Series 701 control valve with a Series 275 pilot float valve. Valves shall be isolated with hand stop valves. A 2” Hand Expansion Valve bypass shall also be included.

2.12 MOTOR CONTROL CENTER

- A. For all refrigeration system equipment provide a separate motor control center. The motor controls center shall have motor circuit protector breakers and starters (part winding) that serve the following equipment:

Ice Chiller Plant Motor Control Center (MCC)

- 1. Chiller compressors (2) (Provide part-winding compressor magnetic starters)
- 2. Glycol pump (2)
- 3. Snowmelt glycol pump
- 4. Controls

- B. All starters shall be sized for 460V/3Ph/60 cycle power. Control power shall be 120V/1Ph/60 cycle. All starters to be part winding type starters.
- C. MCC shall be complete with pilot lights to indicate run status of each motor, overload relays and resets, gauges to indicate system suction pressure & system discharge pressure. Oil pressure gauges shall be mounted at each machine using a steady mount.
- D. All compressor safety controls shall be mounted, piped and wired to the panel. All relays, terminal strips, wiring to U/L, state, and local regulations.
- E. Each motor starter shall be equipped with a H.O.A. selector switch.
- F. All gauges, cutouts and selector switches shall be properly identified with engraved laminated nameplates.
- G. Provide hour meters for each compressor in this panel.

2.13 PUMPS

- A. Pumps shall be base mounted centrifugal type. Iron construction complete with mechanical shaft seals and stainless steel shaft sleeve. Motor shall be high efficiency.

2.14 SNOWMELT PIT HEATING

- A. Provide (1) dedicated heat exchanger and pump for ice melting in the Zamboni pit. Heat exchanger and pump shall be located onboard the ice plant skid. Heat exchanger shall be built in accordance with ASME standards and shall be so stamped.
- B. Provide submerged aluminum coil in Zamboni pit. Include provisions to shield coil from damage during snow discharge into the pit.
- C. All necessary tube side piping including valves, fittings, and hangers required to connect into tie-in connection shall be provided by the Refrigeration and Rink Piping Contractor. Tie-in connections shall be as indicated on the drawings.

2.15 INSULATION

- A. Piping insulation shall be installed on all low pressure liquid and suction lines. Insulation shall be 2" thick urethane or equal with vapor barrier and PVC jacket.
- B. Glycol piping may be pre-insulated or field insulated. Pipe shall be Schedule 40 steel, seamless with 2" of polyurethane foam for chilled water and 1" for heating/snowmelt water. Provide Type 1 Class 1 PVC jacket. Pre-insulated piping to be Thermacor Process or equivalent, site-insulated to be equivalent to Thermacor Process construction as noted.

- C. Domestic hot water piping shall be insulated with 1" fiberglass and all-purpose PVC jacket.
- D. Domestic cold water piping shall be insulated with 1" fiberglass with all-purpose PVC jacket.
- E. Equipment shall be insulated with black urethane insulation and covered with aluminum or PVC jacket.

2.16 THERMOMETERS, PRESSURE GAUGES AND ACCESSORIES

- A. Install 12" scale adjustable angle thermometers, 0 degrees to 100 degrees F., with separable sockets, where shown on drawings.
- B. Gauges shall be installed in suction discharge line of all pumps. Suction side shall be scaled 30" vacuum to 60 lbs. Discharge pressure shall be scaled 0 lbs. to 60 lbs. Dials shall be 4-1/2" diameter. Each gauge shall be valved off. Provide gauges in condenser water inlet and outlets.
- C. Furnish and install multi-purpose valves on discharge line of each glycol pump. The valves shall combine a balancing valve, check valve, and shut-off valve in single body.
- D. Provide bladder expansion tanks and accessories as shown on Flow Diagram.
- E. Provide recording thermometer in discharge line of chillers.
- F. Air release valves at high points of supply and return shall be APCO Air Vent #50, 1" size. Air release valve at air separator shall be APCO 200 A, 2" size. Provide stainless steel ball valve between vent and piping, full port, full size of air valve inlet. Provide an air release valve in floor at rink header return for both heating and cooling headers. Provide access panels. Valve shall be stainless steel, lever handle ball valve.

2.17 CONDENSER REFRIGERANT PIPING

- A. All refrigerant piping shall be Type ACR Copper with wrought copper fittings.

2.18 RINK GLYCOL PIPING

- A. Headers

All glycol piping to and from the rink floors shall be steel Schedule 40 A-53 plain end butt welded. All pipe shall be new, straight and true before fabrication.

- B. Rink Floor Pipe

Arena floor piping shall be 1.25" OD, 1" nominal HDPE HDR 13.5.

C. Pipe Chairs

Provide supporting spacers made of a minimum 3/16" steel rod fabricated with 16 gauge steel plate 3" wide on the bottom.

2.19 REFRIGERANT LEAK DETECTION SYSTEM

- A. Provide a MSA Co. Chillgard 5000 refrigerant leak monitor with multiple sampling points. Provide Chillgard 5000 remote monitor at each room entry point, located just outside the refrigeration room.
- B. Refrigerant leak detection shall be designed for use with R-438a refrigerant.
- C. System shall comply with ASHRAE Standard 15.
- D. Provide two (2) sampling points at opposing ends of the refrigeration skid, 18" above the floor.
- E. Sampling tubing shall be 1/4" I.D. copper. Route tubing runs on Refrigeration Room wall to Chillgard unit.
- F. Run tubing from 18" above to 10' above floor then to wall on which the Refrigeration Control Center is located.
- G. Provide a 4 to 20 MA output signal for each channel outlet to start exhaust system.
- H. Provide each monitor with a filter.
- I. Tie into BMS shall be by Division 23. Power wiring by Division 13. Provide relays to Refrigeration Room exhaust system.

2.20 CONTROLS

- A. Provide a Monitoring and Direct Digital Control System which shall provide local monitoring and display of the ice rink refrigeration plant temperatures and alarms, and shall control the operation of the cooling glycol pumps and the compressors based on these temperature readings. The control system shall be interlocked with the auxiliary equipment such as the snowmelt glycol pump and outdoor condenser.
- B. Provide a prewired control panel for the Monitoring and Control System to contain hand-off-auto selector switches (for control of auxiliary equipment), audible alarm horn, pilot lights and an LCD operator terminal (display and integral key pad) built into the panel door.

C. Equipment Specifications:

1. The control system shall consist of the following:
 - a. CPU.
 - b. 120 volt digital input modules.
 - c. Discrete relay output modules.
 - d. Analog input modules.
 - e. Printer.
2. The door mounted operator terminal shall have a 4-line by 20 Character, 5 function keys, numeric keypad, LCD Display, and Password protection capability or equivalent.
3. Temperature Transducers shall be 1000-ohm Platinum RTD, DIN 43760 with 4-20 ma interface modules, scaled to suit the individual application.
4. The operator terminal, pilot lights, switches, and interface modules shall be mounted in a prewired "NEMA-12" enclosure.
5. The above control equipment description does not preclude the ice system contractor from using a pre-packaged digital and/or analog based control system developed by the ice system contractor as long as the control sequences stated herein are met.
6. Provide backup controller to operate the ice rink refrigeration system in event of failure of DDC system.
 - a. Provide rechargeable lead acid type with sufficient ampere-hour rating to operate the system under supervisory and trouble conditions, including audible trouble signal devices for 24 hours and audible and visual signal devices under alarm conditions for an additional 5 minutes. House batteries either within the control panel or in a separate substantial steel cabinet, and finish on inside and outside with enamel paint; equip with a non-corrosive base and cylinder lock. Separate cells to prevent contact between terminals of adjacent cells and between terminals and other metal parts. Locate cabinet to allow convenient viewing and servicing of the batteries. A separate cabinet shall have twice the volume of batteries it will contain. The battery cabinet, if provided, shall be identified REFRIGERANT LEAK DETECTION SYSTEM BATTERY CABINET with a red and white engraved plastic sign permanently affixed to the face of the panel.
 - b. Provide solid state automatic float type, capable of recharging completely discharged batteries to fully charged condition in 24 hours or less. Locate charger within the control panel or within the battery cabinet. Provide voltmeter and ammeter to indicate battery voltage and charging current.

D. Alarms:

1. The control system shall monitor and alarm the following safety and operating controls including but not limited to the following:

- a. Each compressor shall have the following:

- 1) Low suction pressure.
- 2) High discharge pressure.
- 3) Lube oil failure/motor overload.
- 4) Fail to start.

- b. Low suction head pressure.
- c. High discharge head pressure.
- d. Failure of each pump to start.
- e. High and low cold glycol temperature, condenser water temperature, arena slab temperatures and arena subfloor temperatures.
- f. Emergency alarm.

This panel shall use the display capabilities of the operator interface terminal to indicate the specific alarm. The display terminal shall have the capabilities of also being a logging device which shall retain the last 100 alarm occurrences for review at any time by the operator.

2. The display shall also provide indication for the analog alarms which may occur and for which pilot lights would be impractical. The alarm queue shall also include a date time stamp for each alarm occurrence.
3. Provide a standard alarm matrix. A matrix of 8 contacts shall provide a discrete pattern for up to 63 alarm conditions. Display the current alarm pattern for a minimum of 30 seconds. After 30 seconds, any new alarm occurrence shall overwrite the existing pattern.
4. The control system shall operate the local panel mounted alarm horn, including silence feature. The operator shall be able to view the current alarm(s) as well as the previous 100 through the operator terminal.
5. Provide auxiliary dry contacts for fire alarm interface for alarm when a leak is detected.

E. Motor Start/Stop and Run Status:

1. Cold Glycol Pumps
2. Outdoor Condenser
3. Snowmelt Pumps
4. Jacket and Oil Cooling Pumps
5. Compressors

F. Temperature Readings:

1. The temperature sensors shall be RTD's, mounted in wells or conduit bodies.
2. The following temperatures shall be monitored and displayed through the operator terminal:
 - a. Rink Slab Temperature, (2) locations, in rink floor.
 - b. Cooling Glycol Supply Temperature.
 - c. Cooling Glycol Return Temperature.
 - d. Evaporative temperature.
 - e. Condensing temperature.
3. For control purposes, the operator shall be able to select the average or all of the ice rink temperature transducers to control the operation of the compressors.
4. Each temperature shall have its' own discrete high and low alarm values which can be changed through the operator terminal.
5. Control set points shall be changeable through the operator terminal with optional password protection.
6. Conduit, wiring and installation shall be by this Contractor.
7. The printer shall provide hourly print-out of readings selected by the operator.

2.21 AIR-COOLED CONDENSER

- A. The air cooled condenser shall be forced draft, Baltimore Air Coil, Gunter, or equivalent. Provide modulating capacity control.

PART 3 - EXECUTION

3.1 REFRIGERANT SYSTEM DEHYDRATION, LEAK TESTING AND CHARGING

- A. Dehydrate system by "Double Dehydration" method.
- B. Use a suitable vacuum pump. Evacuate system to a vacuum of 0.2" Hg absolute and operate pump for eight (8) hours when that pressure is reached.
- C. After eight (8) hours, admit dry nitrogen directly to the system, and then evacuate system to a vacuum of 0.2" Hg absolute and operate pump for four (4) hours.
- D. Test for leaks by use of carbon dioxide or nitrogen and a liquid soapsuds solution. Correct leaks found.
- E. Evacuate system to 20" vacuum and charge with refrigerant until a pressure of 15 psig is reached. Then test for leaks using a Halide leak detector.

- F. Pressurize system, with carbon dioxide or nitrogen, to 300 psig on the high side, and 200 psig on the low side, and test for leaks. Correct leaks found.
- G. When system dehydration is complete and all leaks corrected, charge system with refrigerant.

3.2 OIL CHARGE

- A. Contractor shall provide a complete initial charge of oil for the compressors.

3.3 RINK GLYCOL PIPING

- A. Headers

Provide manual air release valves at return headers outside the dashers on the cooling and heating mains. The arena header piping shall have nominal 6" SDR-11 with nominal 1" saddles fused at 6" centers for pipe spacing of 3".

- B. Rink Floor Pipe

Install piping 3" on centers. Fasten polyethylene piping by means of fusion welding at the headers.

Return bends shall be SDR-11 180 degrees on 3" centers.

- C. Pipe Chairs

Pipe chair supports shall space rink piping as specified and shall be placed on 2'-0" centers.

- D. Testing

Rink floor and header systems shall be tested with minimum of 50 psi air pressure, 48 hours prior to pouring of concrete. Pressure shall remain on the floor for the duration of the pour.

3.4 INSERTS AND ACCESSORIES

- A. Provide and set the inserts for the perimeter railing system. Brass plugs shall be provided for all inserts, together with two (2) plug wrenches.
- B. Care shall be taken in tack welding to avoid burning floor piping. Inserts shall be carefully lined and leveled with transit before pouring of concrete floor.
- C. All inserts shall be set 1/8" below floor level.
- D. Provide shop drawing submittal showing location of all inserts for review by Architect and Engineer.

3.5 GLYCOL CHARGE

- A. Provide, mix and charge into system a complete charge of 40% ethylene glycol. When system is fully charged, glycol shall have a freezing point of -13 degrees F. Charge shall have factory mixed inhibitor or neutralizing agent and shall be completely stabilized. One (1) full drum (55 gallons) shall be furnished as spare.
- B. Provide to Owner, at no additional cost, not less than one each three months after final acceptance of plant, for a period of one year, a chemical analysis of glycol charge, together with recommendation for correction of glycol, if necessary. Required corrective measures to glycol for a period of one (1) year from final acceptance shall be paid by Refrigeration Installer.
- C. Copies of report shall be sent to the Owner, Architect, and Ice Rink Design Engineer.
- D. Provide ethylene glycol for heating/snowmelt system with the same specifications as the Refrigeration System.

3.6 INSULATION AND PIPE COVERING

- A. Equipment and piping shall be tested and approved before insulation is applied. Surfaces shall be clean and dry. Insulation shall be installed only by persons regularly employed and skilled in this trade. Insulation sections or segments shall be properly cut and fitted to each surface, tightly butted together and secured. Seams and joints shall be thoroughly sealed with an approved fire retardant joint sealer as recommended by manufacturer.

Provide vapor barrier on all cold temperature pipe.

Equipment to be insulated includes chiller (insulated at factory) glycol piping, heating pipe, refrigerant pipe. (See Part 2 for insulation requirements).

3.7 FLOOR AND WALL PLATES

- A. Pipes passing through finished floors or walls shall be provided with suitable split chrome-plated escutcheon plates. Escutcheon plates shall be sized to cover ends of pipe insulation and walls or floor sleeves, where such occur.

3.8 IDENTIFICATION

- A. All fabricated steel shall be primed and painted. All piping shall be painted in the mechanical room.
- B. All refrigerant lines, glycol lines, and water lines pertaining to the ice rink refrigeration system will be identified after painting and insulation as to the substance in the pipe, and the direction

of flow. All lines penetrating a wall section must be immediately identified on either side of the wall. Markers shall be by Brady, IIAR, or equal.

3.9 CONTROL SEQUENCE OF OPERATION

- A. A Motor Control Center (MCC) shall provide motor starter for all refrigeration compressors and pumps. Each starter shall be sized for 460V/3PH/60HZ power. Control power shall be 120V/1PH/60HZ. Each motor starter shall be equipped with a H.O.A. selector switch.

MCC shall be complete with pilot lights to indicate run status of each motor, overload relays and resets, and gauges to indicate suction pressure and discharge pressure. All compressor safety controls shall be mounted piped and wired to the control panel. Provide run time indication for each compressor at the control panel.

Provide an adjustable anti-recycle timer for each compressor wired to each compressor start circuit to prevent excessive motor starts.

Compressors shall be staged to maintain ice floor temperature and/or return cold glycol temperature once one glycol pump and the outdoor condenser are operating.

Compressors shall not start unless at least one glycol pump is operating and positive status is received from the outdoor condenser.

- B. The ice temperature for rink shall be sensed by two (2) rink floor sensors. Software shall be capable of using a combination of temperature signals to cycle rink glycol pumps to maintain a proper floor ice temperature.
- C. Outdoor condenser shall operate continuously whenever at least one compressor operates.
- D. Snowmelt pumps to be manually controlled.
- E. Flooded evaporators controlled by a liquid level probe which controls feed of liquid refrigerant to each evaporator.
- F. Provide to the building automation system (1) overall alarm indication relay contact and (1) relay contact to start/stop the refrigeration room exhaust system.

3.10 ERECTION AND TESTING AND TEST RUN

- A. The above specified equipment, materials, and accessories shall be carefully installed and erected by skilled mechanics. Fusion welders are to be experienced in type of welding they perform. Architect may demand a welding test if he deems it advisable.
- B. After piping is laid on ice rink proper and fused to headers and glycol connections back to chiller room are completed, a 50# psi air and soap test shall be applied; after this test, a 50#

psig hydrostatic test shall be put on system for a period of not less than twenty-four (24) hours, after all leaks have been repaired. This test must be witnessed and approved by the Architect. Air pressure of minimum 15 psi shall be maintained on rink piping during the pouring of concrete floor. Glycol system shall be thoroughly tested and flushed clean before glycol is charged into system. This Contractor shall keep a welder on duty during the pouring of floor.

- C. Refrigeration Installer shall be solely responsible for charging of glycol and refrigerant into system.
- D. Refrigeration Installer shall provide qualified engineers to supervise the operation of first run and test run of plant. Test run for freezing first sheet of ice shall be for three (3) days after pre-determined date. Refrigeration Installer shall furnish necessary help required to spray ice rink for purpose of making ice during three day test run. The Chiller Manufacturer shall provide factory start-up for the chillers. The freezing of the ice shall be under the supervision of the installing contractor.
- E. Owner shall furnish a person who will be instructed by Refrigeration Installer's supervising engineer regarding care and operation of system. Time for starting test shall be agreed upon by Architect, an operating log-form to record operating conditions during test run. This record shall be kept by Refrigeration Installer's supervising engineer.
- F. Refrigeration Installer shall furnish three (3) complete sets of operating instructions bound in stiff covers. These manuals shall contain bulletins describing parts of equipment in refrigeration and glycol circulating system, repair parts bulletin, description of methods of starting plant, instruction for summer shut-down period, wiring diagram and other material pertinent to operating and maintenance of plant. These manuals shall be turned over to Architect.
- G. Initial freezing of ice rink shall not take place until not less than twenty-eight (28) days have elapsed from time of pouring and finishing of concrete ice rink, and the completion of the expansion control system.
- H. The Refrigeration Contractor shall install the first slab of ice to 1/4".
- I. The first flood shall be made with hot water at 140 degrees to seal the ice.
- J. Fine spray water, cold or hot, shall be sprayed until the 1/4" thickness is achieved, to the approval of the Engineer.
- K. After miscellaneous tests and mechanical work has been completed to satisfaction of Architect, Refrigeration Installer shall give notice in writing to the Architect that he is ready to commence a test run.
- L. Upon conclusion of test run, the Architect and Engineer shall make a complete, thorough, and final inspection of the plant and will elaborate to the Refrigeration Installer in writing details that are to be corrected.

3.11 TESTING ADJUSTING AND BALANCING

- A. Refrigeration contractor shall contract with a test and balance firm to test, adjust and balance the hydronic system. Also Contractor shall have a registered engineer responsible for the work and shall have prior approval by the Architect/Engineer. Testing shall be done by certified technicians.
- B. References:
 - 1. ASHRAE - Standard 111 - 1988 Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air Conditioning, and Refrigeration Systems.
 - 2. ASHRAE - 1987 HVAC Systems and Applications Handbook: Chapter 57, Testing, Adjusting and Balancing.
 - 3. NEBB - Procedural Standards for Testing, Balancing, and Adjusting of Environmental Systems.
- C. Submittals:
 - 1. Submit name of Adjusting and Balancing Firm for approval within thirty (30) days after award of contract.
 - 2. Submit for review, prior to commencement of work, a list of equipment and procedures to be used in balancing the systems.
 - 3. Submit reports of pre-construction plan check and periodic mechanical construction review.
 - 4. Submit draft copies of report for review prior to final acceptance of project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.
- D. Procedures and Report:
 - 1. Hydronic Systems shall be balanced using a procedure which results in minimum restrictions being imposed. At completion of balancing provide a report with the following information.
 - a. Instrument List:
 - 1) Instrument
 - 2) Manufacturer
 - 3) Model
 - 4) Serial number
 - 5) Range
 - 6) Calibration date
 - b. Electric Motors:
 - 1) Manufacturer
 - 2) HP

- 3) Phase, voltage, amperage, nameplate, actual
- 4) RPM
- 5) Service factor
- 6) Starter size, rating, heater elements

c. V-Belt Drive:

- 1) Identification
- 2) Driven sheave, diameter
- 3) Belt, size and quantity
- 4) Motor sheave, diameter
- 5) Center to center distance, maximum, minimum, and actual
- 6) Final components

d. Pump Data:

- 1) Identification/number
- 2) Manufacturer
- 3) Size/model
- 4) Impeller diameter
- 5) Service
- 6) Design flow rate, pressure drop
- 7) Actual flow rate, pressure drop
- 8) Discharge pressure
- 9) Suction pressure
- 10) Total operating head pressure
- 11) Shut off, discharge and suction pressures
- 12) Shut off, total head pressure

e. Evaporator and Condenser:

- 1) Identification/number
- 2) Manufacturer
- 3) Capacity
- 4) Model
- 5) Evaporator entering glycol temperature, design and actual
- 6) Evaporator leaving glycol temperature, design and actual
- 7) Evaporator pressure drop, design and actual
- 8) Evaporator glycol flow rate, design and actual
- 9) Condenser entering water temperature, design and actual (including heat recovery side)
- 10) Condenser leaving water temperature, design and actual (including heat recovery side)
- 11) Condenser pressure drop, design and actual
- 12) Condenser water flow rate, design and actual

f. Heat Exchanger:

- 1) Identification/number
- 2) Location
- 3) Service
- 4) Manufacturer
- 5) Model
- 6) Primary glycol entering temperature, design and actual
- 7) Primary glycol leaving temperature, design and actual
- 8) Primary glycol flow, design and actual
- 9) Primary glycol pressure drop, design and actual
- 10) Secondary refrigerant entering temperature, design and actual
- 11) Secondary refrigerant leaving temperature, design and actual

g. Glycol Flow Measuring Station:

- 1) Identification/number
- 2) Location
- 3) Size
- 4) Manufacturer
- 5) Model
- 6) Design flow rate
- 7) Design pressure drop
- 8) Actual/final pressure drop
- 9) Actual/final flow rate
- 10) Station calibrated setting

h. Sound Level Report:

- 1) Location
- 2) Octave bands - equipment off
- 3) Octave bands - equipment on

i. Vibration Test:

- 1) Location of Points:
 - a) Fan bearing, drive end
 - b) Fan bearing, opposite end
 - c) Motor bearing, center (if applicable)
 - d) Motor bearing, drive end
 - e) Motor bearing, opposite end
 - f) Casing (bottom or top)
 - g) Casing (side)

- 2) Test Readings:
 - a) Horizontal, velocity and displacement
 - b) Vertical, velocity and displacement
 - c) Axial, velocity and displacement
- 3) Normally acceptable readings, velocity and acceleration
- 4) Unusual conditions at time of test
- 5) Vibration source (if non-complying)
- j. Rink Sensor Temperatures: (Rink Floor)
 - 1) Description of sensor under test
- k. Rink Glycol Temperature:
 - 1) Temperature leaving rink
 - 2) Temperature entering rink
- 2. Report is to include a listing of any abnormal or notable conditions not contained in above.
- 3. Provide four (4) copies of reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
- E. Contractor Responsibilities:
 - 1. Prepare each system for testing and balancing.
 - 2. Cooperate with testing organization, provided access to equipment and systems. Operate systems at designated times, and under conditions required for proper testing, adjusting and balancing.
 - 3. Notify testing organization seven (7) days prior to time system will be ready for testing, adjusting and balancing.
- F. Examination:
 - 1. Before commencing work, verify that systems are complete and operable. Ensure the following:
 - a. Equipment is operable and in safe normal condition.
 - b. Temperature control systems and rink dehumidification system are installed complete and operable.
 - c. Proper strainer baskets are clean and in place.
 - d. Correct pump rotation.
 - e. Proper strainer baskets are clean and in place.
 - f. Service and balance valves are open.

G. Installation Tolerances:

1. Adjust Hydronic Systems to the following tolerances:

a. Chilled Ethylene Glycol System:

- 1) Supply 40% ethylene glycol temperature below 45 degrees F: -5% to +5% of design value.

H. Adjusting:

1. Recorded data shall represent actually measured, or observed condition.
2. Permanently mark settings of valves, dampers, and other adjustment devices, allowing settings to be restored.
3. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
4. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

END OF SECTION 13 10 61

SECTION 13 10 62 - RINK FLOOR

PART 1 - GENERAL

1.1 SCOPE

- A. The Ice Rink Contractor will be responsible for the proper supervision and installation of the rink slab from the structural slab including minimum 7" of insulation, reinforcing, concrete, and floor inserts (as required).
- B. Warranties: The flooring contractor shall guarantee floor for a period of two years after the successful completion and approval by the Owner's representative. The guarantee shall cover dusting, disintegration or any other defects of the surface coming within the control of the Contractor.
- C. The Ice Rink Contractor will be responsible for submitting a stamped and signed rink floor design to the authority having jurisdiction. The Ice Rink Contractor shall engage a qualified structural engineer licensed in the State of Colorado for this design.

PART 2 - MATERIALS

2.1 REINFORCED REFRIGERATED CONCRETE SLAB

- A. Provide all labor, materials, equipment, services and protection for the complete installation of a reinforced concrete slab. The rink floor shall be a wire mesh reinforced concrete slab with a minimum thickness of 5". The total thickness of the concrete over the freezing pipes shall not exceed 1-1/2".
- B. Expansion Joint Compression Seal: Furnish and install a 1" compression seal expansion joint system for the ice slab as manufactured by Watson Bowman Acme.

The seal shall be performed and manufactured from a thermoplastic rubber compound.

Lubricant Adhesive - Rima-Lub Adhesive shall be a one part moisture curing polyurethane and aromatic hydrocarbon solvent moisture which complies with ASTM D-4070.

PART 3 - INSTALLATION

3.1 REINFORCING STEEL

- A. The slab will be reinforced with #4 bars at 12" centers in both direction below the pipes. All bars will be intermediate grade deformed steel free from rust or scale without sharp offsets or bends. Longitudinal bars for bottom reinforcing will not be less than 20 ft. lengths and the minimum lap will be 1'-3". The bars will be placed beginning 4" clear of the bulkhead on each side and ends of the rink.
- B. The first layer of #4 re-rod shall be laid parallel to the rink pipe supports at 12" centers. The second layer of #4 re-rod shall be laid longitudinal at 12" centers over the first layer of re-rod and the base plate of the rink pipe supports.
- C. The two layers of reinforcing steel below the pipe will then be tied together with wire ties at a minimum of 12" intervals in two directions.

3.2 CONCRETE MIX AND INSTALLATION

- A. The concrete mix will be designed with admixtures to produce a compressive strength of 6,000 psi in 28 days. Any concrete admixtures shall be compatible with the specified ice rink floor piping. The mix design must be approved by the Owner's representative. Aggregate must be clean and properly graded with a maximum size of ¾". The slump must be maintained at 3-½" to 4-½" to allow for complete flow around the piping system.
- B. The concrete slab will be poured in place using a concrete pump with a minimum output of 35 cr. yds. Per hour. No trucks are to be allowed in the floor area and the use of power operated buggies will not be permitted. A stand-by pump shall be provided.
- C. Runways will be 4' x 8' x ¾" plywood sheets in good structural condition laid on the pipe chair supports.
- D. Concrete will be placed in 10 ft. - 12 ft. lanes running transversely across the rink starting at the one side and maintaining this same direction each time so that new concrete will be placed against the oldest concrete on the previous lane. Care must be exercised to prevent damage to the piping system.
- E. After concrete placing has been commenced it must be carried on continuously until completion. The changing of shifts must be done so that there is no delay in pouring and meal hours for the crew must be staggered to avoid any stoppage in the pouring. The concrete shall be struck off at the exact 8" thickness and finished with rotary steel floats until all laitence has disappeared.
- F. Testing: Testing of the concrete will be provided by the Owner's special inspector. It will be the Ice Rink Contractor's responsibility to coordinate this testing with the Owner's special

inspector. Test cylinders will be taken to a total of six throughout the pour and will be tested for compressive strength at 7 days and 28 days. Cylinders are to be stored at the project, under the same conditions of temperature and moisture as the floor, until tested.

- G. Surface Tolerances: The rink slab shall be installed in accordance with the following ACI tolerances. Tolerances shall be maintained regardless of slab-on-grade or elevated slab application.
 - A. $F_f = 65$ (overall)/ $F_f = 45$ (local minimum)
 - B. $F_l = 40$ (overall)/ $F_l = 30$ (local minimum)
- H. Finishing: The surface of the slab shall be finished with power driven rotary trowels following immediately behind the pouring crew.
- I. Hardener: When the slab is in condition to receive a hardener, a non-metallic hardener shall be uniformly applied as recommended by the manufacturer to ensure a smooth even finish free of all irregularities and blemishes. Hardener shall be applied at the rate of 60 lbs. Per 100 sq. ft. of surface.
- J. Curing and Protection: A continuous moist cure shall be maintained during the finishing process for a period of 7 days. On completion on finishing the entire slab area shall be covered with polyethylene sheets with care being taken to lap all joints. Polyethylene is to remain in place free of traffic for a period of ten days. The Ice Rink Contractor is responsible for protection against vandalism damage through the hardening process for a further period of 7 days.

3.3 EXPANSION JOINT INSTALLATION

- A. All surfaces to receive elastomeric compression seal shall be free from dirt, water, frost and any other loose foreign debris which may be detrimental to effective joint sealing.
- B. The seal shall be supplied in the longest continuous length possible. Factory splices will be allowed.

3.4 FINISHED SURFACE PAINTING

- A. The finished refrigerated slab surface shall be painted white prior to first ice slab installation.

END OF SECTION 13 10 62

SECTION 13 10 63 - ICE RINK INSULATION

PART 1 - GENERAL

1.1 THIS CONTRACTOR SHALL FURNISH AND INSTALL THE FOLLOWING:

- A. Thickness as shown on architectural drawings.
- B. Vapor Barriers.

PART 2 - MATERIALS

2.1 INSULATION

- A. Rink insulation shall be Dow Styrofoam 60 Hi-Load insulation, supplied in sheets 2'-0" x 8'-0".

- 2.2 Vapor barrier shall be 6 mil. Poly, with fortified grade 495 pressure sensitive tape.

PART 3 - INSTALLATION

- 3.1 Install vapor barrier on under insulation. All joints shall be overlapped no less than 6" and sealed with fortified grade 495 pressure sensitive tape.
- 3.2 The insulation shall be applied in layers. Joints between layers shall be staggered in both directions. Final surface shall be leveled to plus or minus 1/8". After level has been checked by engineer, insulation is to be glued.
- 3.3 The vapor barrier on top of and below the insulation shall be provided by this contractor. Vapor barrier shall be fortifiber poly foil barrier laid with all joints lapped six (6) inches, and sealed as above.

END OF SECTION 13 10 63

SECTION 13 10 64 – ICE MAINTENANCE EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Provide the following tools and equipment for maintenance for the ice system.

PART 2 - PRODUCTS

2.1 TOOLS AND EQUIPMENT

- A. Provide two (2) lightweight aluminum ice squeegees with removable rubber blade. Units to be “U” shaped with adjustable blade 36” wide with 54” aluminum handle.
- B. Provide two (2) lightweight aluminum ice rink scrapers complete with adjustable 40” blade and 54” aluminum handle.
- C. Provide one (1) tempered carbon steel ice chipper with 8” blade, overall length 60”. Blade to be hardened after fabrication.
- D. Provide 250’ of 1” double braided, oil resistant, red rubber hose, complete with couplings.
- E. Provide one (1) fog nozzle with capacity of 23 GPM.
- F. Provide one (1) hand operated hose reel, capacity 250’ - 1” hose, all arranged for wall mounting with hand crank operation. Provide two (2) 1” hoses - 10’ long with automatic shut off nozzles for Zamboni cold water and Zamboni hot water.

PART 3 - NOT USED

END OF SECTION 13 10 64

SECTION 21 13 00 - FIRE SUPPRESSION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide a complete fire protection system as indicated on the Drawings and as specified herein consisting of the following but not limited thereto.
 - 1. Wet standpipe system.
 - 2. Wet, dry, deluge and pre-action fire sprinkler systems.
 - 3. Exterior fire protection piping system.
 - 4. Fire hydrants.
 - 5. Fire extinguishers.
 - 6. Fire pump, jockey pump and controllers.
 - 7. Temporary standpipes for construction.
- B. It is the intent of this Specification for the Contractor to provide complete hydraulically designed wet and dry pipe sprinkler systems for the areas indicated in these Specifications and shown on the Contract Drawings. This Contractor shall be the Engineer of record for the fire sprinkler system. Furnish all design, material, and labor to complete the contract within the intent of these Specifications and Contract Drawings even though each and every item necessary is not specifically mentioned or shown.
- C. The Promenade and Plaza buildings shall be provided with a wet fire protection system.
- D. The existing glycol-based Gondola Square fire protection system shall be extended to serve Gold Walk interior areas.
- E. The existing glycol-based Gondola Square fire protection system shall be modified and extended to serve interior renovation projects in Building A, Building C, and Building F.

1.2 QUALITY ASSURANCE

- A. Contractor Qualifications: Work shall be performed by a Contractor regularly engaged in the design and installation of fire protection systems in accordance with NFPA requirements and having at least three years continuous experience in this type of work. Experience shall include projects of similar type, size and complexity.

- B. Design Criteria: Provide fire protection systems of types, pressure, flow and densities required by the prevailing edition of the NFPA 13 and regulatory agencies having jurisdiction.
1. Systems shall be calculated and of configuration acceptable to regulatory agencies.
 2. Provide sprinkler head densities per NFPA 13 and as shown on documents.
 3. Fire pump shown on the plans is of adequate size to serve the system. Notify engineer prior to bid if this does not appear to be the case. Pressure losses throughout the system shall be within the capacity of the scheduled pump. The contractor may propose, at his option, increased pressure loss due to reduced system pipe sizing resulting in a larger pump. It will be the contractor's responsibility to cover all costs (space requirements, electrical impact, etc.) associated with the increased pump size and horsepower.
- C. Pipe sizes shown on drawings may be larger than minimum required. This is to accommodate additional partitioning. Do not reduce sizes.
- D. Requirements of Regulatory Agencies: Total system shall be acceptable upon completion and testing in accordance with the requirements of the following:
1. Jurisdictional Code Enforcement Agencies
 2. Jurisdictional Insurance Agency or Underwriter
 3. Confirm requirements of the authority having jurisdiction and Owner's Insurance Underwriter prior to bid.
- E. Certificate of Completion: Submit Certificate of Completion of fire protection work, stating that the work has been completed and tested in accordance with the specified standards, that there are no defects in the system and it is operational.

1.3 CODES AND STANDARDS

- A. Comply with local fire department regulations and with the following:
1. Standpipe system
 - a. UBC Standard 38-2
 2. Local Water Department
 3. Local Building Department
 4. FM Global
 5. Local Health Department
 6. Local Public Works
 7. Prevailing editions of NFPA 13, 14, 24
 8. Local modifications to the Fire Codes
 9. UL 218 Standard for Fire Pump Controllers
 10. UL 1008 Automatic Transfer Switches
 11. UL 508 Industrial Control Equipment

- 12. NFPA 20 Installation at Centrifugal Fire Pumps
- 13. NFPA 70 National Electrical Code

- B. All materials and equipment used in the installation of the fire protection system shall be as listed in the Underwriters' Laboratories, Fire Protection Equipment Directory or approved in the Factory Mutual Approved Guide and shall be the most current product of the manufacturer, and shall bear their label.

1.4 SUBMITTALS

- A. Submittal data shall be in accordance with Division 1 and the following shall be submitted for review to the Architect prior to the start of installation:
 - 1. Material and equipment information shall include catalog cuts and technical data for each system component or device. This shall include, but not be limited to piping, fittings, globe and angle valves, O.S.&Y valves, butterfly valves, check valves, automatic sprinkler heads, escutcheons, hangers, flow switches, tamper switches, alarm valves, trim and required accessories, dry pipe valves, trim and required accessories and air compressor.
- B. Prepare shop drawings showing layout of fire protection system. Use minimum scale of 1/8" = 1'-0" for floor plans. Drawings shall coordinate with all building structural features and components and show routing of piping to clear same. Drawings shall be accurately dimensioned to show proposed location of all fire protection system components. System design shall be completely coordinated with the architectural, structural, mechanical, and electrical features of the building. The drawings shall show all details required by NFPA 13 - Sprinkler System, Installation for "Working Drawings". In all areas with suspended ceilings, reflected ceiling plans shall be prepared showing the location of sprinklers, lights, diffusers, grilles, etc.
- C. Submit a complete schedule of the material and equipment proposed for this installation to the Architect/Engineer for approval. Include catalog cuts, diagrams, drawings, and such other descriptive data as may be required to clearly show what, where, and how the component is intended to be installed. In the event any items of material or equipment contained in the schedule fail to comply with the specifications, such items may be rejected.
- D. Submit plans and hydraulic calculations signed and sealed by the Professional Engineer supervising the design of the fire sprinkler system, and one (1) set of reproducible of the complete shop drawings of the sprinkler system to the regulatory agencies having jurisdiction. After approvals are obtained, submit the drawings and hydraulic calculations to the Architect for review. Written approval of the Architect must be obtained before purchasing or installing any equipment.
- E. Approval of submittals will not relieve the Contractor of the responsibility for correcting any errors which may exist or for meeting requirements of the specifications. No partial submittals will be accepted.

- F. A set of approved installation drawings shall be kept at the job site and marked to indicate all installation conditions which are different from the approved drawings.

1.5 DESIGN REQUIREMENTS

- A. It shall be the Contractor's responsibility to size the sprinkler system pipes in accordance with the requirements of the prevailing edition of NFPA 13. Contractor shall submit all calculations to the Engineer for review at time of drawing submittal. Submittal of these calculations to the Engineer will in no way relieve the Contractor of his responsibilities for complete and proper design of the fire protection system.
- B. It shall be the Contractor's responsibility to design the system so that no interferences exist between the fire protection system and work of other trades, equipment and systems designed and installed by others. The latest issues of all architectural, structural, mechanical and electrical drawings will be furnished for reference to assist the Contractor in preparing the design so as to avoid interference.
- C. This Contractor shall provide all necessary control wiring and equipment necessary for an operational system. This includes, but not limited to, key switches, releasing panels, solenoid valves, etc.

1.6 WATER SUPPLY

- A. The water supply as shown on the drawings will be installed by other divisions of the work, who will provide a flange connection inside the building for the fire protection system. The fire protection Contractor shall make the required connection at this point for the fire protection system. Coordinate with General Contractor prior to bid to show the complete scope of work between civil and the fire protection contractor.

1.7 WARRANTIES

- A. The entire new system shall be warranted to be free from defects for a period of one (1) year from the date of Notice of Acceptance.

1.8 PROJECT RECORD DOCUMENTS

- A. Upon completion of the work, the Contractor shall revise all fire protection drawings to agree with the construction as actually accomplished and stamp "As-Built". Those drawings where no change is involved shall be likewise stamped. These "As-Built" drawings shall show the fire protection system as it existed at the completion of the contract work.
- B. See Division 1 for additional requirements.

1.9 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including the General Conditions of the Contract and Supplementary General Conditions and Division 1 - General Requirements, apply to work of this Section. This Contractor shall comply with all applicable sections of Division 21 through 23.

PART 2 - PRODUCTS

2.1 WET PIPE AND FITTINGS

- A. Pipe joints above ground shall be screwed, flanged, welded, roll-grooved with mechanical couplings. Welded joints are not acceptable in pipe less than 2" in diameter. No welding permitted except with certified welders in shop.
- B. Piping above ground shall be Schedule 40 black steel pipe. Thin wall schedule 10 pipe may be used when in conformance with NFPA 13 and when approved by the applicable Fire and Building departments.
- C. Threaded fittings above ground shall be gray cast iron suitable for 175 psi cold water working pressure and so rated.
- D. In lieu of weld, threaded, or flanged connections, mechanical type couplings and fittings as manufactured by Tyco Grinnell Grooved Piping Products and Victaulic or approved equal, may be used in piping above grade.
- E. Provide escutcheons on penetrations of interior walls.
- F. Below Grade:
 - 1. Ductile iron pressure pipe, tar coated, cement lined:
 - a. Pipe: ANSI A21.51, Class 50
 - b. Fittings: ANSI 21.10
 - c. Rubber gaskets: ANSI 21.11
- G. Any piping used shall have a UL Corrosion Ratio (CRR) of 1.00 or greater.

2.2 DRY PIPE AND FITTINGS

- A. Pipe joints above ground shall be screwed, flanged, welded, cut-grooved with mechanical couplings. Rolled grooved will not be allowed in dry pipe systems. Welded joints are not acceptable in pipe less than 2" in diameter. No welding permitted except with certified welders in shop.

- B. Piping above ground shall be Schedule 40 black steel pipe.
- C. All fittings on galvanized piping shall be galvanized in accordance with ASTM A153.
- D. Fittings shall be suitable for 175 psi cold water working pressure and so rated.
- E. In lieu of weld, threaded, or flanged connections, mechanical type couplings and fittings as manufactured by Tyco Grinnell Cut Grooved Piping Products and Victaulic or approved equal, may be used in piping above grade.
- F. Provide escutcheons on penetrations of interior walls.
- G. Any piping used shall have a UL Corrosion Ratio (CRR) of 1.00 or greater.
- H. Nitrogen Generator with Integral Air Compressor:
 - 1. Basis-of-Design – Subject to compliance with requirements, provide Engineered Corrosion Solutions Nitrogen Generator.
 - 2. The nitrogen generator shall be wall mounted with integral air compressor sized to provide all dry and preaction fire sprinkler systems with supervisory nitrogen gas. Sizing shall be based on the total volume of all fire sprinkler systems being served by the nitrogen generator as determined by hydraulic calculations for each system. Documentation of the calculations and nitrogen generator sizing must be provided with the submittals. Where the quantity of systems, total cumulative volume of systems or physical location of system risers require, multiple nitrogen generators shall be supplied.
 - 3. The nitrogen generator shall be electronically controlled with the capability to adjust system operating pressure settings without the requirement of any additional equipment.
 - 4. The nitrogen generator shall include an integral air compressor sized per the manufacturer's requirements.
 - 5. The integral air compressor shall be oil-less, be rated for continuous duty and have an output pressure rating of 100 psig.
 - 6. The integral air compressor shall be capable of producing a continuous volume of compressed air that is sufficient to fill the largest FPS being supplied by the air compressor to operating pressure within thirty (30) minutes per NFPA 13 requirements and also meet the compressed air requirements of the nitrogen generator it is supplying.
 - 7. The nitrogen generator shall not require a nitrogen storage tank or refrigerated dryer.
 - 8. The nitrogen generator shall be designed to achieve a nitrogen concentration of 98% or greater within fourteen (14) days of start-up and maintain that concentration within all fire protection systems continuously.
 - 9. The nitrogen generator shall have a connection to attach and sample the purity of nitrogen within the FPS. Purity sampling device can be portable or fixed.
 - 10. The nitrogen generator shall be equipped with a filtration system to remove residual water and hydrocarbons (if needed) from the compressed air stream.
 - 11. The nitrogen generator shall be powered by a 120VAC power supply. Coordinate power requirements and location with electrical contractor. The nitrogen generator power supply shall be per NFPA 70 and all local requirements.

12. The nitrogen generator shall be equipped with an internal bypass with bypass alarm to prevent long term oxygen exposure in fire sprinkler system.
13. Coordinate power requirements and location with electrical contractor. The nitrogen generator power supply shall be per NFPA 70 and all local requirements.
 - a. Air Maintenance Device:
 - 1) The fire sprinkler contractor shall furnish and install an approved air maintenance device for each dry or preaction fire sprinkler system.
 - 2) The air maintenance device shall be equipped with a field adjustable pressure regulator for use in setting the maximum system pressure. Approved air maintenance devices are:
 - a) Victaulic Series 757
 - b) Tyco Model AMD-1
 - c) Reliable Model A-2
 - d) Or approved equal
 - 3) Air maintenance device shall be installed per the manufacturer's instructions.
 - b. Integral Air Vent (electric):
 - 1) The fire sprinkler contractor shall furnish and install an electric integral air vent for each fire sprinkler system that will close automatically once the desired nitrogen concentration has been reached.
 - 2) The electric integral air vent shall be installed on the fire sprinkler riser at the locations shown on the drawings. Installation of the electric integral air vent outside of the fire sprinkler valve room is not permitted.
 - 3) The electric integral air vent shall be equipped with a solenoid valve and separate electric control box. The electric integral air vent shall be powered by a 120VAC power supply. Coordinate power requirements and location with electrical contractor.
 - 4) The electric control box shall be wall mounted and installed adjacent to the integral air vent on the fire sprinkler riser. Coordinate solenoid connection requirements and location with electrical contractor.
 - 5) The solenoid valve shall be wired to the electric control box per NFPA 70 and all local requirements.
 - 6) The integral air vent shall have an adjustable pressure regulator to prevent accidental depressurization of the fire sprinkler system should a disruption occur to the air/nitrogen supply
 - 7) The electric integral air vent shall have a connection to attach and sample the purity of nitrogen within the FPS. Purity sampling device can be portable or fixed.
 - 8) The piping between FPS and electric integral air vent must not create a water trap; the connecting piping must drain when FPS is drained or the electric automatic air vent will not function properly.
 - 9) A 1/2 in. outlet is required to attach the vent assembly to the FPS.

- 10) The isolation ball valve of the electric automatic air vent shall be closed during hydrostatic and/or air pressure testing of the FPS and then placed in the open position for the commissioning and operation of the nitrogen generator or cylinders.

2.3 BUTTERFLY VALVES

- A. Butterfly valves shall be furnished with worm gear type indicating operator to assure slow closing. Valves shall have a completely sealed shaft, integral flange seals, and hex drive.

2.4 O.S.&Y. VALVES

- A. Outside stem and yoke gate valves shall be of the wedge disc type, shall permit straight line flow and complete shut-off, and shall be so designed that the valves can be packed under pressure when wide open. Valve shall be iron body, bronze trim, flanged or screwed ends, with rising stem and rated minimum 175 psi non-shock cold water service.

2.5 CHECK VALVES

- A. All swing check valves shall be 175 psi non-shock cold water service, iron body, bronzed trim, horizontal swing with renewable bronze seat and rings. All check valves two (2) inches and smaller shall be bronze, screwed, horizontal swing type. All check valves two and one half (2½) inches and larger shall be flanged or grooved type.
- B. All wafer check valves shall be minimum 175 psi working pressure, iron body with spring actuated double bronze plate and rubber seat.

2.6 GLOBE AND ANGLE VALVES

- A. Valves shall be furnished with renewable disc, non-shock, and shall back seat in the fully opened position to allow repacking under full pressure without removing the valve from the line. Valve shall be rated for minimum 175 psi working pressure.

2.7 VALVE SUPERVISORY SWITCHES

- A. All valves two inches or larger which control water to automatic sprinkler heads shall be equipped with supervisory switches having one normally open contact and one normally closed contact.

2.8 FLOW SWITCHES

- A. All flow switches shall be field adjustable vane type with pneumatic retard and 175 psi working pressure. Units shall be suitable for installation by drilling pipe and securing with U-bolt furnished with the switch. Units shall be single pole double throw, suitable for 24Volt D.C. service with one normally open contact and one normally closed contact. Waterflow switches shall be adjusted so that the device will transmit a waterflow alarm within 30 seconds of opening the inspector's test valve on the sprinkler system.

2.9 FIRE HOSE

- A. Single jacket rubber lined, one and one half (1½) inch, 100 continuous feet, 100 percent synthetic jacket with dacron filler. Hose shall be totally immune to mildew and rot. NST thread.

2.10 FIRE HOSE NOZZLE

- A. One and one half (1½) inch cast brass "ALL FOG" nozzle with rubber bumper for Class A, B, or C fires. No straight stream adjustment. NST thread.

2.11 TAMPER SWITCHES

- A. Approved manufacturers are System Sensor, Potter Electric or equal.
- B. Switch shall be listed for use on the type of valve to be monitored.

2.12 EXTERIOR ALARM

- A. Approved manufacturers are Farr Alarm, Potter Electric, System Sensor.
- B. Alarm shall have combination horn and light and be constructed for exterior use.
- C. Furnish interior alarms where required by the authority having jurisdiction.

2.13 DRY PIPE VALVE

- A. Approved manufacturers are Tyco, Viking, Victaulic and Reliable.
- B. Dry pipe valve shall separate system water supply from the air-filled system piping. Valve shall have an external reset, flanged or grooved connections, gasketed hand hole cover, brass to neoprene air seat, brass-to-brass water seat, spring-loaded clapper with full open latch. Provide all accessories consisting of angle valves, globe valves, pipe nipples and fittings, water and air pressure gauges, mechanical or electrical accelerator when required and maintenance air compressor sized in conformance with NFPA 13.

2.14 AUTOMATIC FIRE SPRINKLER HEADS

- A. Approved manufacturers are Tyco, Viking, Reliable, Victaulic.
- B. Sprinkler heads shall have a temperature rating of 155°F except for heads in areas of high temperature and in close proximity to heat sources which shall be temperature rated in accordance with NFPA 13.
- C. Sprinkler heads in ceilings to be concealed pendent.
- D. Sprinkler heads in exposed areas shall be upright type, standard brass.
- E. Sprinkler heads in dry-pipe systems shall be upright (where exposed) or dry-pendent type (in ceilings).
- F. Sprinklers for installation in wall, ceilings, soffits or similar shall include integral escutcheon plates designed for friction or set screw fit. Escutcheon throat shall be minimum ¾" depth.
- G. Coordinate exact location, type and color of all sprinkler heads, escutcheons and plates with the Architect.
- H. Supply Owner an extra stock of six sprinklers minimum, three of each type, with applicable sprinkler wrenches. Sprinklers shall be packed in a suitable container for wall mounting. Provide additional heads that may be required by NFPA 13.

2.15 FIRE DEPARTMENT CONNECTION

- A. Approved manufacturers are Potter-Roemer, or equal.
- B. Fire department connection shall be 2-way projecting standpipe inlet with self-closing clapper valves and pin lug swivels and caps with chains equal to Potter-Roemer Series 5720 and Potter-Roemer escutcheon plate Series 5960 with appropriate lettering. Furnish with type of thread as directed by the local fire department and of size shown on the drawings.

2.16 FIRE HOSE VALVE

- A. Approved manufacturers are Potter-Roemer, or equal.
- B. 2½" Hose valve with 2½" x 1½" reducer with pin lug cap and chain, polished brass finish equal to Potter-Roemer 4065-B.

2.17 FIRE HOSE CABINET

- A. Approved manufacturers are Potter-Roemer, or equal.
- B. Fire hose cabinet shall be recessed 20-gauge, white, baked enamel steel box, 20-gauge tubular steel door with 18-gauge frame with a continuous steel hinge (brass pin), door and frame finished with a baked-on gray primer coat equal to Potter-Roemer 1500-A.
- C. Cabinet shall contain (3½" hose valve with 2½" x 1½" reducer with pin lug cap and chain - Denver) 1½" hose rack assembly with lined hose and fog nozzle equal to Potter-Roemer; 2½" hose valve with pin lug cap and chain equal to Potter-Roemer 4065; 2½ gallon pressurized water portable fire extinguisher with stainless-steel shell equal to Potter-Roemer 3202.

2.18 ROOF MANIFOLD

- A. Approved manufacturers are Potter-Roemer, or equal.
- B. Cast brass 2-way outlet body equal to Potter-Roemer No. 5840 with No. 4200 gate valves with caps and chains.
- C. Control valve shall be non-rising stem Kennedy No.4701 or equal with wall post indicator Kennedy No. 641-13 or floor stand Kennedy No.2945 as required.

2.19 ALARM CHECK VALVES

- A. Approved manufacturers are Tyco, Viking, Reliable and Victaulic.
- B. Alarm check valve shall provide for the proper functioning of a water motor alarm and/or electric alarm. Valve cover shall allow for replacement of all moving parts without removing the valve from an installed position. Valve shall have flanged or grooved connections. All moving parts shall be brass, bronze or stainless-steel with replaceable neoprene clapper and brass seat. Valve housing shall be tapped to allow installation of alarm accessories, two pressure gauges (one above, and one below the seat) and main drain. Provide all accessories consisting of angle valves, globe valves, orifice restriction, pipe nipples and fittings, retarding chamber, water pressure gauges and circuit closer with two sets of contacts for electric alarms. Valve shall be rated for 175 psi working pressure.

2.20 ALARM DEVICES

- A. Equipment necessary to accomplish a transmitted waterflow signal and auxiliary contacts shall be provided. Main shut-off valves shall be electrically supervised. Any tamper-proof switches

required for testing the sprinkler system shall be furnished. Alarm devices shall be as manufactured by Potter Electric Signal Company or approved equal.

1. Transmitted Alarm: A transmitted alarm shall be provided for the transmission of waterflow signals to the main fire alarm control panel. Wiring shall be provided in Division 26.

2.21 TEST AND STATUS CONNECTIONS

- A. Furnish and install test connection for fire protection system and pipe to appropriate drains.

2.22 MISCELLANEOUS

- A. Nameplate data information: The nameplates shall be installed on each main riser and shall include the following design data: building designation, location of remote area, design density, area of application, and system demand (GPM and PSIG at base of riser).
- B. Control valve signs: The Contractor shall provide a description sign, minimum dimensions seven (7) inches by nine (9) inches, for every valve in the preaction system which controls water to sprinkler heads. Signs shall be single faced, white letters on a red background, with a space designating who to notify if valve needs to be closed. Signs shall be fastened to each valve with lightweight chain.
- C. Miscellaneous signs: These signs for alarm test valves, main drains, auxiliary drains, etc. shall have minimum dimensions of two (2) inches by six (6) inches. Signs shall be single faced, white letters on a red background. Each sign shall be fastened to each valve with lightweight chain.

PART 3 - EXECUTION

3.1 PREPARATION

- A. The Contractor shall investigate the conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, and accessories as may be required to meet such conditions. The Contractor shall field verify all dimensions and conditions governing his work at the building. Materials shall not be fabricated or delivered to the site before the approved submittals have been received by the Contractor.

3.2 GENERAL INSTALLATION

- A. Investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, and accessories as may be required to meet such conditions. The Contractor shall field verify all dimensions and conditions governing his work

at the building. Materials shall not be fabricated or delivered to the site before the approved shop drawings and equipment submittals have been received by the Contractor.

- B. Entire installation shall be in accordance with approved shop drawings. When unforeseen job site conditions will not permit piping to be installed as shown on the drawings, necessary changes will be made to accomplish a coordinated system without additional cost to the Owner, even though pipe may have been delivered to the site cut to predetermined lengths.
- C. Provide gate valves of size and at locations shown on the drawings and any additional valves required by local authorities. Locate all valves where readily accessible. Provide chain wheel operators or permanent ladders for all valves not accessible from the floor. All main line valves shall be electrically monitored or secured with a chain and padlock which will lock the valve in an open position.
- D. Provide check valves of size and at location shown on the drawings and any additional check valves that might be required by local authorities.
- E. Provide valved test drains as required by NFPA. Pipe test drains to spill on grade whenever possible or to nearest floor drain, or receptor.
- F. Make provisions to drain all parts of the piping system.
- G. All dry pipe/preaction system piping shall be back pitched (sloped) to drain points. 1/2" per 10' for branch piping and 1/8" per 10' for mains. Provide auxiliary drains at all low points.
- H. The hydraulic calculations shall be performed in accordance with the requirements of NFPA 13 and 14. The Contractor shall calculate the demand point for the system so that it remains ten (10) percent below the final water supply curve at the connection to the public water system. The demand point for the systems shall include an allowance for the inside and outside hose demand. The basis for the hydraulic calculations shall be determined by a waterflow test performed by the Contractor and acceptable to the Authority Having Jurisdiction.
- I. Be responsible for trenching, bedding material, removal of waste material, paving removal and replacement, barricades, and any materials necessary for vehicle and person access across work areas.
- J. Bedding shall be well graded non-expansive, non-organic soil containing no rocks over one (1) inch in diameter. There shall be no refuse of corrosive materials in this soil.
- K. All bedding and backfill shall be laid and compacted in accordance with Section 23 05 03 and Division 2.
- L. Drain termination: all express drains.

3.3 PIPING INSTALLATION

- A. Perform the work in a professional workmanlike manner, according to the best practices of the trade. All sprinkler piping must be substantially supported from the building structure and only approved type hangers shall be used. Sprinkler piping in all areas shall be concealed unless otherwise noted on the contract drawings. In those noted locations and in areas with no ceiling, piping shall be installed as high as possible using necessary fittings and auxiliary drains to maintain maximum height. Any deviations found necessary shall be immediately brought to the attention of the Architect. All piping discharging outside (main drains, inspectors test pipes) shall do so on paved surfaces or on splash blocks.
- B. All inside piping shall be joined by means of threaded, flanged, flexible gasketed joints, or other approved method. Risers, feed mains, cross mains, and branch lines may be shop welded using approved welding fittings. Welding and brazing shall conform to the standards as set forth in NFPA #13. Welding and torch cutting shall not be permitted as a means of installing or repairing sprinkler system piping on-site.
- C. Provide expansion compensation loops at all building expansion joints and other areas where thermal and structural movement may require.
- D. Chrome-plated escutcheons shall be provided where exposed piping passes through finished floors, walls, partitions, and ceilings. Secure plates to pipe with set screws or spring clips.
- E. Refer to section 23 05 53 for pipe labeling requirements. Piping identification will also be subject to the requirements of applicable codes.

3.4 AUTOMATIC FIRE SPRINKLER HEAD INSTALLATION

- A. All sprinkler heads shall be in alignment, and parallel to ceiling features, walls, etc. The Contractor shall be responsible for the removal and replacement of ceilings, providing ceiling access panels, cutting, patching and restoration of finishes as necessary.
- B. Conform to spacing and dimensional constraints indicated by the Architect on the reflected ceiling plans.
- C. Sprinkler heads shall be centered within ceiling grid.

3.5 FIRE STOPS AND PENETRATION SEALS

- A. All new piping penetrations through fire rated floors and walls shall be sealed with fire resistant sealant to prevent the spread of smoke, fire, toxic gas, and water through the penetration either before, during or after a fire. The fire rating of the penetration seal shall be at least that of the floor or wall into which it is installed.
- B. See Section 23 05 03 for requirements.

3.6 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install check valve and ball drip valve where they will not be subjected to freezing temperatures. The discharge line from the ball drip valve shall be visible.

3.7 FIRE HOSE CABINET INSTALLATION

- A. Branch piping to valves must have rigid bracing independent of fire hose cabinet.

3.8 PRESSURE GAUGE INSTALLATION

- A. Install pressure gauges at the following locations: street side of check valve; at system side of all control valves. Each gauge connection shall not be less than 1/4" and shall be equipped with a shut-off valve and with provision for draining.
- B. The required pressure gauges shall be 3" diameter minimum and shall have a maximum limit not less than twice the normal working pressure at the point where installed. They shall be installed to permit removal, and shall be located where they will not be subject to freezing.

3.9 TAMPER SWITCH INSTALLATION

- A. Install tamper switches on all control valves.

3.10 FIRE ALARM WIRING

- A. All fire alarm and monitor wiring shall be done under the Electrical Division but the proper operation will be the fire protection Contractor's responsibility.

3.11 FLOOR CONTROL VALVE INSTALLATION

- A. Floor control valve shall be a complete assembly consisting of an OS&Y valve, grooved butterfly, or pressure control valve, vane type flow switch with retard chamber, inspector's test and main drain valves. Preassembled UL/FM floor control assemblies equal to Tyco Riser Manifolds are allowed.
- B. Pipe discharge from inspector's test and main drain valves through sight glass and orifice to a drain riser.
- C. This contractor shall install drain risers to serve floor control valves.

3.12 PIPE TESTING

- A. The entire fire protection piping system shall be tested hydrostatically at not less than 200 psi pressure for two hours, or at 50 psi in excess of the maximum static pressure when the maximum static of NFPA pressure is in excess of 150lbs. The hydrostatic test pressure shall be measured at the low point of the individual system or zone being tested. Each complete system (all associated piping and alarms), shall be tested and accepted as a complete unit, with data recorded on an approved "Contractor's Material and Test Certificate". System pressure tests shall be against a blank test flange and not against a valve seat.
- B. All tests shall be conducted in the presence of the Architect and Owner. Any system failing to meet the specified test requirements shall be retested at no additional cost, until the test requirements are met.

3.13 FIRE EXTINGUISHERS

- A. Install where shown on plans in wall-mounting bracket in accordance with manufacturer's directions.
- B. Comply with the requirements of NFPA 10.

3.14 MAINTENANCE AND OPERATIONAL INSTRUCTIONS

- A. System description, system theory of operation, and system final inspection and acceptance documents of the completed system (as built) shall be submitted in a bound book as described in Division 1. The maintenance manuals and instructions shall include a brief description of the type of system installed, routine-type maintenance work defined by step-by-step instructions that should be performed to ensure long life and proper operation, and the recommended frequency of performance. The instructions shall also include possible trouble spots with diagnosis and correction of each. The theory of operation brochures shall describe the function of each component or subassembly in block-diagram type presentation to a degree that a craftsman will understand the system well enough to operate and maintain it.

3.15 PROTECTION

- A. Protect all apparatus, fixtures, materials, equipment, and installations so as to prevent damage as a result of new work. The Contractor shall replace at his own expense any item, which is marred, defaced, broken, or damaged in any way, prior to the date of Notice of Acceptance.

END OF SECTION 21 13 00

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 REFER TO RELATED SECTIONS

- A. Section 23 05 01 – Mechanical and Electrical Coordination
- Section 23 05 02 – Basic Mechanical Requirements
- Section 23 05 03 – Basic Mechanical Material and Methods
- Section 23 05 13 – Motors and Starters
- Section 23 05 21 – Pipe and Pipe Fittings
- Section 23 05 22 – Piping Accessories
- Section 23 05 23 – Valves
- Section 23 05 29 – Pipe Support and Anchors
- Section 23 05 30 – Electronic Speed Controllers
- Section 23 05 48 – Vibration Control
- Section 23 05 53 – Mechanical Identification

PART 2 - NOT USED

PART 3 - NOT USED

END OF SECTION 22 05 00

SECTION 22 05 50 - PLUMBING SEISMIC RESTRAINTS

PART 1 - GENERAL

1.1 REFER TO RELATED SECTIONS

- A. Section 23 05 49 – Seismic Restraints

PART 2 - NOT USED

PART 3 - NOT USED

END OF SECTION 22 05 50

SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 REFER TO RELATED SECTIONS

- A. Section 23 07 00 – Mechanical Insulation

PART 2 - NOT USED

PART 3 - NOT USED

END OF SECTION 22 07 00

SECTION 22 08 00 - COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 REFER TO RELATED SECTIONS

- A. Section 23 08 00 – Building Mechanical System Commissioning.
Section 23 08 01 – Commissioning Agent Requirements

PART 2 - NOT USED

PART 3 - NOT USED

END OF SECTION 22 08 00

SECTION 22 10 00 - PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS



- A. Drawings and general provisions of Contract, including General and Supplemental Conditions of the Construction Contract and Division 1 Specification Sections (General Requirements), apply to this Section.

1.2 SUBMITTALS

- A. Submit manufacturer's data on the following:
 - 1. Pressure reducing valves.
 - 2. Backflow preventers.
 - 3. Water hammer arresters.
 - 4. Piping products, fitting and connection methods.
 - 5. Roof drains, floor drains, floor sinks, cleanouts and area drains.
 - 6. Downspout nozzles.
 - 7. Manhole frames and covers.
 - 8. Backwater valves.
 - 9. Catch-basins and covers.
 - 10. Water meter and meter pit.
 - 11. Trap primers
 - 12. Trap guards
 - 13. Thermostatic mixing valves
- B. Submit complete drain down written procedure and drain-down diagrams with the Operation and Maintenance Manuals.
 - 1. Diagrams shall indicate each valve, and its location, used for facility drain down. Diagram shall be based on installed condition.

1.3 STANDARDS

- A. Materials shall comply with the following standards.
 - 1. Cast iron pipe:
 - a. ASTM A-74
 - b. CISPI 301

- c. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute ® and listed by NSF® International.
- 2. Cast iron pipe fittings:
 - a. ASTM A-888
 - b. CISPI 301
 - c. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute ® and listed by NSF® International.
- 3. Cast iron pipe joints
 - a. Standard Duty Hubless Couplings shall conform to CISPI Standard 310 and be certified by NSF® International.
 - b. Heavy Duty Hubless couplings shall conform to ASTM C 1540 and shall be used if indicated.
 - c. Gaskets for Service Weight hub & spigot shall conform to ASTM C 564
- 4. Copper pipe:
 - a. Type K, L, M: ASTM B88
 - b. DWV: ASTM B306-88
- 5. Ductile iron pipe: ASTM A377-89
- 6. All components in contact with potable water shall be listed for compliance to NSF 61 Lead Free requirements.
- 7. PVC PIPE AND FITTINGS
 - a. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
 - b. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns

1.4 RELATED WORK

- A. Section 23 05 29 Pipe Supports and Anchors.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER PIPING AND ACCESSORIES

- A. Above Ground Inside Building, Size 4" and Under:
 - 1. Pipe: Copper tube, hard temper, Type L.
 - 2. Fittings: Wrought copper or cast bronze.

3. Solder: 95-5 tin antimony (no lead).
4. Refer to section 230521 for other acceptable joining methods for copper tube 4" and smaller.

B. Above Ground Inside Building, Size 4" and Larger:

1. Stainless-steel pipe, Schedule 40 with any of the following fittings: (Schedule 10 as approved by Owner.)
 - a. 125 lb. Stainless flanged, threaded or welded.
 - b. Stainless grooved pipe fittings, designed for rolled or cut grooved joint, 275 lb. working pressure.
 - 1) Manufacturers:
 - a) Grinnell
 - b) Gruvlok
 - c) Victaulic

C. Above Ground Inside Building, (Option for up to 8")

1. Copper tube, hard temper, Type L, with grooved joints/pipe systems designed for potable water.

D. Below Ground Inside Building, Size 2" and Under:

1. Pipe: Copper tube, annealed, Type K.
2. Fittings: Wrought copper, brazed.

E. Below Ground Outside Building, 2 1/2" and Over:

1. Ductile pressure pipe, tar coated, cement lined:
 - a. Pipe: ANSI A21.51, Class 50.
 - b. Fittings: ANSI 21.10.
 - c. Rubber Gaskets: ANSI 21.11.

F. Use approved fittings for connections between dissimilar pipe systems.

2.2 DOMESTIC WATER PRESSURE REDUCING VALVE

A. Manufacturer:

1. Design Basis: Watts Model LF223S (1/2" through 2-1/2")
2. Other Acceptable Manufacturers:
 - a. Beeco
 - b. Febco
 - c. Wilkins
3. Construction:
 - a. Seal: Renewable, stainless steel.
 - b. Strainer: Stainless steel.
 - c. Diaphragm: High temperature resistant.
 - d. Must comply with NSF 61 and NSF/ANSI 372

2.3 BACKFLOW PREVENTER, (REDUCED PRESSURE ZONE TYPE) (FOOD SERVICE OTHER THAN CARBONATORS AND COFFEE MAKERS)

A. Manufacturer:

1. Design Basis: Watts No.SS009QT Series
2. Construction: Stainless-steel trim and body, complete with test cocks, resilient seat, shut-off valves, and air gap fitting.
3. Other Acceptable Manufacturers:
 - a. Beeco
 - b. Febco
 - c. Wilkins
4. Complies with ASSE STD 1013
5. Must comply with NSF 61 and NSF/ANSI 372.

2.4 BACKFLOW PREVENTER, (DUAL CHECK WITH ATMOSPHERIC PORT) (FOOD SERVICE CARBONATORS AND COFFEE MAKERS)

A. Manufacturer:

1. Design Basis: Watts No.SD-3
2. Construction: 316 Stainless-steel trim and body, NSF approved

3. Other Acceptable Manufacturers:
 - a. Febco
 - b. Wilkins
4. Extend vent to floor sink/drain
5. Complies with ASSE 1022
6. Must comply with NSF 61 and NSF/ANSI 372

2.5 BACKFLOW PREVENTER, (REDUCED PRESSURE ZONE TYPE) (DOMESTIC WATER SERVICE)

A. Manufacturer:

1. Design Basis: Watts No. LF909, (1/2" through 10")
2. Construction: Bronze body, stainless-steel trim, complete with test cocks, resilient seat, shut-off valves, and air gap fitting. Provide with strainer.
3. Other Acceptable Manufacturers:
 - a. Febco
 - b. Wilkins
4. Complies with ASSE STD 1013.
5. Must comply with NSF 61 and NSF/ANSI 372.

2.6 BACKFLOW PREVENTER (DOUBLE CHECK) (FIRE PROTECTION SERVICE)

A. Manufacturer:

1. Design Basis: Watts No. 709 (2-1/2" through 10")
2. Construction: Epoxy coated cast iron body, replaceable bronze seats.
3. Other Acceptable Manufacturers:
 - a. Beeco
 - b. Febco
 - c. Wilkins
4. Complies with ASSE STD 1015.

2.7 BACKFLOW PREVENTER (ATMOSPHERIC VACUUM BREAKER)

A. Manufacturer:

1. Design Basis: Watts No. LF008 Series (3/8" through 1")
2. Construction: Bronze body, ball valve shut offs.

3. Other Acceptable Manufacturers:
 - a. Febco
 - b. Wilkins
4. Complies with ASSE STD 1020.
5. Must comply with NSF 61 and NSF/ANSI 372.

2.8 WATER HAMMER ARRESTER (SHOCK ABSORBERS)

- A. Manufacturers:
 1. Design Basis: Zurn Shoktrol Z-1700
 2. Construction: Stainless Steel, Bellows
 3. Other Acceptable Manufacturers:
 - a. J.R. Smith
 - b. Josam
 - c. PPP, inc
 - d. Sioux Chief
 4. Standards: PDI WH201, ASSE STD 1010.
 5. Must comply with NSF 61 and NSF/ANSI 372.

2.9 TRAP PRIMERS (TP)

- A. Manufacturers:
 1. Design basis: PPP as noted in Plumbing Fixture Schedule.
 2. Construction: Corrosion resistant brass. "O" rings shall have a flexibility range of -40°F to 450°F.
 3. Provide distribution units for connector points as shown on plans.
 4. Complies with ASSE STD 1018.
 5. Must comply with NSF 61 and NSF/ANSI 372.

2.10 TRAP GUARDS (TG)

- A. Manufacturers:
 1. Design basis: ProSet Trap Guard
 2. Construction: A flexible tube made of elastomeric material that is treated to roll up when water is passing through drain.
 3. Install in floor drains and floor sinks from 2" up to and including 4" as shown on plans indicated with a (TG) behind drain designation.

4. Larger sizes can be custom made by ProSet upon request.
5. Use of trap guards as approved by local authority.

2.11 WATER METER

- A. Meter shall be located in pit exterior to building.
- B. Meter and pit shall be furnished and installed under civil division. Piping shall be extended to within 5'0" of building by site utility contractor. Mechanical contractor shall verify and coordinate location and elevation of connection point.

2.12 SANITARY AND VENT PIPING (WITHIN BUILDING)

- A. Above Ground:
 1. Cast iron hub and spigot, neoprene gasket.
 2. Cast iron no hub, neoprene gasket and stainless-steel sleeve joint.
 3. DWV copper with DWV fittings, solder joint.
 4. PVC schedule - 40 solid core (As approved by local building department and Owner).
 - a. No PVC allowed in exposed areas due to acoustics.
- B. Exposed in finished spaces:
 1. DWV copper with DWV fittings.
- C. Underground:
 1. Cast iron hub and spigot, neoprene gasket.
 2. PVC schedule 40 - solid core (approved by local building department and Owner).

2.13 HEAVY DUTY NO HUB COUPLINGS

- A. Heavy Duty Couplings shall conform to ASTM C1540.
- B. Use on the following:
 1. Sanitary vent piping 4" and larger.
 2. Sanitary piping 3" and larger.
 3. All storm piping.
- C. 1-1/2", 2", 3" and 4": 3" wide 304 stainless-steel shield; (4) minimum stainless-steel clamps; fixed and "floating" eyelet.

- D. 5" and over: 4" wide 304 stainless-steel shield, with six (6) stainless-steel clamps mounted in series.
- E. Torque to minimum 80-inch pounds or per manufacturer's recommendation.
- F. Acceptable manufacturers: Husky Series 4000, Mission Heavy Weight and Charlotte Pipe.

2.14 STANDARD DUTY COUPLINGS

- A. Standard duty couplings shall conform to CISPI 310-85: 0.008" thick corrugated stainless steel.
- B. Use of the following:
 - 1. Sanitary vent piping up to and including 3" piping.
 - 2. Sanitary piping up to and including 2" piping.
- C. Torque to inch pounds per manufacturer's recommendation.
- D. Acceptable manufacturers: Tyler, Mission, AB&I, Clamp All, Huskey and Charlotte Pipe.

2.15 PUMPED SANITARY PIPING (ABOVE AND BELOW GRADE)

- A. DWV copper with DWV fittings, solder joint.
- B. 125 lb. galvanized steel, threaded.
- C. Galvanized malleable or ductile iron grooved pipe fittings, designed for cut grooved joint.
- D. Hub and spigot or no hub couplings are not allowed.

2.16 SOIL AND VENT PIPING PRODUCTS

- A. Use approved fittings for connections between dissimilar pipe systems.
 - 1. For transitions above slab, couplings shall conform to ASTM C1460
 - 2. For transitions below slab, couplings shall conform to ASTM C1173
- B. Manufacturers:
 - 1. Acceptable Manufacturers:
 - a. J.R. Smith
 - b. Jones Spec
 - c. Josam
 - d. Wade

- e. Watts Ancon
- f. Zurn

C. Cleanout Plugs:

- 1. Material: Cast bronze or brass.
- 2. Type: Countersunk.
- 3. Threads: ANSI B2.1.

D. Wall Cleanout Covers:

- 1. Type: Frameless, round, low profile plate.
- 2. Material: Stainless steel or chrome plated brass.
- 3. Attachment: Single exposed flush screw.
- 4. Finish:
 - a. Non-painted surfaces: Bright polished.
 - b. Surfaces to be painted: Prime coat.

E. Floor Cleanouts:

- 1. Body: Standard round Duco cast iron.
- 2. Attachment: Bronze screws.
- 3. Sleeve: Full thickness of floor slab.
- 4. Top:
 - a. Shape:
 - 1) Where floor covering has rectangular pattern: Square.
 - 2) Other areas: Round.
- 5. Cover:
 - a. For Vinyl Tile and Similar Floor Coverings: Recessed to receive inset of floor material.
 - b. For carpeted floor covering provide carpet cleanout marker.
 - c. Other areas: Nickel bronze scoriated finish.
- 6. Provide heavy duty floor cleanouts for all areas accessible by vehicles or forklift traffic.

F. Exterior Cleanouts to Grade:

- 1. Material: Duco cast iron.
- 2. Ferrule: Caulk type.
- 3. Plug: Cast bronze countersunk type.

- G. Vandal-Proof Caps
 - 1. Material: Duco cast iron.
 - 2. Attachment: Recessed Allen set screw.

- H. Backwater Valve:
 - 1. Material: Duco cast iron.
 - 2. Valve: Bronze.
 - 3. Provide cleanout cover.
 - a. Locate in accessible manhole.

2.17 SANITARY SEWER PIPING (BELOW GRADE-EXTERIOR TO BUILDING)

- A. Match material and methods specified in Division 2 for sitework sanitary sewer system or as listed below.
- B. Use approved fittings for connections between dissimilar pipe systems.
- C. Plastic Pipe:
 - 1. Acceptable Manufacturers:
 - a. Carlon
 - b. Johns-Manville
 - c. Robintech
 - 2. Material: PVC ASTM D3034
 - 3. Strength: SDR35

2.18 MAN-HOLES

- A. Concrete Base:
 - 1. Construction: Poured in place.
 - 2. Material: 3000 lb. concrete.
- B. Man-Holes
 - 1. Construction: Pre-cast or poured in place.
 - 2. Material: ASTM C478

C. Frames and Covers:

1. Material: Grey cast iron, ASTM A48 Class 30B
2. Meets or exceeds FS RR-F-621.
3. Legend: Cast in "Sanitary" or "Storm" as required.
4. Steps: Grey cast iron, ASTM A48 Class 30B.

D. Type:

1. Rated for H-20 (Heavy Truck) wheel loading.
2. Neenah R-6099 or equivalent.
 - a. 48" clear opening or as required by application. Coordinate any alternate size with Architect/Engineer.

2.19 STORM WATER PIPING (INSIDE BUILDING)

A. Above Ground:

1. Cast iron, hub and spigot, neoprene gasket joints.
2. Cast iron no hub, neoprene gasket and stainless-steel clamps.
3. Schedule 40 galvanized steel with screwed or grooved mechanical fittings. (Optional: Welded joints)
4. Schedule 40 PVC – solid core (As approved by local building department and Owner).
 - a. No PVC allowed in exposed areas due to acoustics.

B. Underground:

1. Cast iron hub and spigot, neoprene gasket.
2. PVC schedule 40 - solid core (approved by local building department and Owner).

2.20 STORM WATER PIPING (BELOW GROUND-EXTERIOR TO BUILDING)

- A. Match material and methods specified in Division 2 for sitework storm sewer system or as listed below.
- B. Match materials and methods specified for soil and vent piping above.
- C. Use approved fittings for connections between dissimilar pipe systems.

2.21 STORM DRAINAGE PRODUCTS

A. Acceptable Manufacturers:

1. J.R. Smith
2. Jones Spec
3. Josam
4. Wade
5. Watts Ancon
6. Zurn

B. Roof Drain: (RD)

1. Material: Cast Iron
2. Dome: Cast Iron
3. Include:
 - a. Combined flashing collar and gravel stop.
 - b. Extension for insulation.
 - c. Under-deck clamp.
 - d. Sump receiver.
 - e. Expansion joint.

C. Overflow Roof Drain: (OD)

1. Same as Roof Drain Type 1 except:
 - a. Provide water dam. Top of water dam shall be 2" above low point of roof or per local code if different.

D. Downspout Nozzle: (DSN)

1. Material: Cast bronze body and flange.

2.22 SAND AND OIL INTERCEPTOR

A. Materials:

1. Pre-formed or cast concrete.

B. Capacity: See plans.

C. Design:

1. Comply with local authority having jurisdiction.
2. Two compartment.
3. Two access manholes with ladders and manhole covers. Covers to be cast with "Sewer".

4. Design to be H2O loading in all traffic areas
5. See detail shown on plans for general requirements.

2.23 GREASE INTERCEPTOR

- A. Materials:
 1. Pre-formed or cast concrete.
- B. Capacity: See plans.
- C. Design:
 1. Comply with local authority having jurisdiction.
 2. Two compartment.
 3. Two access manholes with ladders and manhole covers. Covers to be cast with "Sewer".
 4. Design to be H2O loading in all traffic areas
 5. See detail shown on plans for general requirements.

2.24 GREASE AND OIL TRAPS (INDIVIDUAL FIXTURE) (MANUAL)

- A. Acceptable manufacturers:
 1. J.R. Smith
 2. Josam
 3. Wade
 4. Zurn
- B. Construction: Fabricated steel with acid resistant coating inside and outside.
- C. Capacity as noted on drawings. Manual type.
- D. Accessories: Flow control fitting, removable baffles, threaded inlet and buffet, extension collar as required, internal air relief, double wall trap without cleanout and gasketed scoriated cover.
- E. Approval Standard: Plumbing and Drainage Institute (PDI) approval.

2.25 GREASE TRAPS (INDIVIDUAL FIXTURE) (AUTOMATIC)

- A. Furnish and install Thermaco Big Dipper Model No. W-350-IS, bright finish type 304 stainless-steel exterior, rotationally molded polyethylene interior automatic self-cleaning grease and oil recovery separator(s) for floor-mounted or partially recessed installation, rated at 35 gallons per minute (2.21 l/s) peak flow, 70 pounds (31.8 Kg) of grease capacity and including as an integral part of the unit, 1 rotating gear hydrophobic wheel assembly for automatic grease/oil removal, an integral flow control device, self-regulating enclosed electric immersion

heater, a vessel vent, an integral gas trap, a digital control for programmable operation, a field reversible motor location, a field reversible grease/oil sump outlet, quick release stainless-steel lid clamps, a gasketed and fully removable 304 stainless-steel lid, a lift-out strainer basket access, an internal stainless-steel strainer basket for collection of course solids, and a separate grease and oils collection container. Electric assembly shall be tested to comply with pertinent sections of the Standards for Safety ANSI/UL 73 and/or ANSI/UL 1004. Electric motor equipped with overload protection. Two (2) no-hub connectors for plumbing connection provided.

2.26 SEDIMENT INTERCEPTORS

- A. Acceptable Manufacturers
 - 1. Park Environmental “Trash Trooper”

2.27 THERMOSTATIC MIXING VALVES

- A. Master Type - ASSE 1017 Devices
- B. Individual or Group - ASSE 1070 Devices

PART 3 - EXECUTION

3.1 GENERAL

- A. Testing: Test in accordance with the applicable Plumbing Code.
- B. Connections to Equipment Furnished Under Other Sections:
 - 1. Make final connections to all equipment shown on drawings as connected to supply and/or drain piping.
 - 2. Furnish all devices necessary for final connection, including:
 - a. Tail pieces
 - b. Stops
 - c. Supplies
- C. Corrosion Protection:
 - 1. Provide isolation between concrete or mortar and any copper pipe.
 - 2. All below grade piping shall be adequately protected from corrosion.
- D. Comply with Section 23 05 29 Pipe Supports and Anchors for pipe support requirements.

3.2 INSTALLATION OF DOMESTIC WATER PIPING AND PRODUCTS

- A. Install all horizontal water piping level and parallel to building construction (except piping noted to be drained down slope toward drain at 1/8" /ft. min.). Make any changes in direction with fittings, don't kink or bend. All vertical piping to be plumb. Provide dielectric isolation between uninsulated pipe and hangers. Provide plastic grommets when going through metal studs. Tape is not acceptable for dielectric isolation.
- B. Backflow Preventer:
 - 1. Provide backflow preventer requirements as follows:
 - a. Reduced pressure at make-up for hydronic systems.
 - b. Vacuum breaker at all hose bibbs.
 - c. Reduced pressure on water entry.
 - d. Reduced pressure on irrigation systems.
 - e. Stainless steel reduced pressure on water lines to carbonated beverage dispensers and ice makers.
- C. Water Hammer Arrestors:
 - 1. Provide water hammer arrestors in the piping systems and adjacent to all pieces of equipment wherein quick-closing vales are installed.
 - 2. Water hammer arrestors shall be properly sized and selected per PDI Standard WH 201 and having sufficient displacement volume to dissipate the calculated kinetic energy generated by the piping system. Install all units in a vertical position.
 - 3. Provide access panels.
 - 4. Install water hammer arrestors as close as possible to inlet side of quick closure valves and devices.
 - 5. Install water hammer arrestors in upright position on inlet side of solenoid valve.
 - 6. Do not install water hammer arrestors at greater than 90-degree angle from vertical position.
 - 7. Water hammer arrestors extended to above ceiling are not acceptable.
- D. Disinfection:
 - 1. After installation of all fixtures served, fill all domestic water lines with a chlorine-water solution of 50 parts per million minimum.
 - 2. Hold solution in pipe for at least 24 hours.
 - 3. Open and close all valves 3 times during chlorination.
 - 4. Waste chlorine solution from each outlet.
 - 5. Measure solution at end. If not 10 ppm, repeat.
- E. Meters:
 - 1. Install water meter in accordance with Water Supplier's standard.

- F. Pressure Reducing Valves: Install pressure gauges upstream and downstream of all pressure reducing valves.

3.3 INSTALLATION OF SANITARY AND VENT PIPING

- A. Couplings: See Part 2 for use of standard and heavy-duty couplings.
- B. Gaskets: Install gaskets in accordance with manufacturer's recommendations for the use of lubricants, cements, and other special installation requirements.
 - 1. Joint Adapters: Make joints between cast iron pipe and other types of pipe with standard manufactured cast iron adapters and fittings.
 - 2. All no-hub couplings and fittings to be restrained from movement in accordance with CISPI Standard 310.
 - 3. Make all cast iron joints as detailed in the Cast Iron Soil Pipe Institute's Handbook
- C. Joint Adapters: Make joints between cast iron pipe and other types of pipe with standard manufactured cast iron adapters and fittings as detailed in Part 2.14.A.
- D. All buried thermoplastic piping shall be installed in strict conformance of ASTM D2321.
- E. Do NOT use compressed air or gases to test Drain, Waste, and Vent Systems or Storm Systems
- F. Cleaning Piping:
 - 1. Clear the interior of pipe of dirt and other superfluous material as the work progresses.
 - 2. Place plugs in the end of uncompleted pipe at the end of the day or whenever work stops.
- G. Test Plugs:
 - 1. Provide test plugs in floor drains and roof drains at the time of installation.
 - 2. Leave test plugs in place for the duration of construction until sewer or drainage system is complete.
- H. Vent Flashing:
 - 1. Provide 4 lb. sheet lead (24" x 24" minimum).
 - 2. Extend lead 5" above the vent and turned down into vent pipe.
 - 3. Refer to Section 7600 for single ply roof system components.
- I. Vent Location: Do not install vents within 2 ft. of roof edge, parapet, wall line, or an "on-the-roof structure" and within 10 ft. of any air intake.

J. Cleanouts:

1. Provide cleanouts as required by code.
2. Provide cleanouts for end runs of all water closet, urinal and lavatory batteries.
3. Final locations of cleanouts to be approved by the Architect for all finish spaces.

K. Grease, and Sand/Oil Interceptors and Traps:

1. Provide solid unexcavated earth or concrete support under interceptors.
2. Do not support interior traps from floor extension.
3. Vents from these interceptors shall extend separately to the outdoors.

3.4 INSTALLATION OF STORM DRAINAGE PIPING (ABOVE GROUND WITHIN BUILDING)

A. Couplings:

1. Utilize heavy duty, 8 psi, no-hub couplings for cast iron. No-hub may only be used on piping within 20' below the roof. This limitation is to prevent a failure of the no-hub couplings in the event of a downstream system blockage. In lieu of this restriction adequate relief or coupling restraints per 3.4.A.3, must be provided and approved by the engineer.
2. Threaded or mechanical couplings with galvanized piping are acceptable for all locations.
3. All no-hub couplings and fittings to be restrained from movement in accordance with CISPI Standard 310.

B. Gaskets: Install gaskets in accordance with manufacturer's recommendations for the use of lubricants, cements, and other special installation requirements.

C. Joint Adapters: Make joints between cast iron pipe and other types of pipe with standard manufactured cast iron adapters and fittings.

D. Cleaning Piping:

1. Clear the interior of pipe of dirt and other superfluous material as the work progresses.
2. Place plugs in the end of uncompleted pipe at the end of uncompleted pipe at the end of the day or whenever work stops.

E. Test Plugs:

1. Provide test plugs in floor drains and roof drains at the time of installation.
2. Leave test plugs in place for the duration of construction.

F. Roof Drains:

1. Install drains on the center line of sheet lead pan.
2. Clamp flashing into drain flashing collar.
3. Install domes immediately after completion of roof installation.

G. Expansion:

1. Provide a vertical expansion joint at each connection to roof drain unless an offset is provided.
2. Where piping crosses building expansion joints, provide swing or expansion joints to allow for building movement.

H. Downspout Nozzles: Install with flange secured to wall at base of concealed storm leaders that discharge through the building wall above grade.

I. Provide sway bracing and anchorage of piping as required by local code. At a minimum provide sway bracing at changes of direction greater than 45 degrees for pipes 4" or larger.

**3.5 INSTALLATION OF SANITARY SEWER AND STORM WATER PIPING
(EXTERIOR TO BUILDING)**

A. Couplings: See Part 2 for use of couplings.

B. Lay piping true to the grades and alignment indicated with unbroken continuity of invert.

C. Install gaskets in accordance with manufacturer's recommendations for the use of lubricants, cements and other special installation requirements.

D. Install plastic pipe in accordance with pipe manufacturer's written instructions.

E. Install cast iron hub and spigot pipe under roads and paved areas.

F. Clear the interior of piping of dirt and other superfluous material as the work progresses. Maintain a swab or drag in the line and pull past each joint as it is completed.

G. Place plugs in the end of uncompleted conduit at the end of the day or whenever work stops.

H. Flush lines if required to remove collected debris.

I. Make joints between cast iron pipe and other types of pipe with standard manufactured cast iron adapters and fittings.

J. Grout joints between cast iron pipe and concrete pipes thoroughly with cement mortar to make watertight joint.

- K. Inspect conduit to determine whether line displacement or other damage has occurred.
 - 1. Make inspection after lines between manholes, or manhole locations, have been installed and approximately 2 ft. of backfill is in place and at completion of the project.
- L. If the inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, take whatever steps are necessary to correct such defects to the satisfaction of the Architect/Engineer.
- M. Set grade cleanouts located in unpaved and asphalt paved areas in 12" x 12" x 4" concrete pad.
 - 1. Provide concrete pad.

3.6 MANHOLES

- A. Precast Concrete Manholes:
 - 1. Place precast concrete sections as shown on the drawings.
 - 2. Where manholes occur in pavements, set tops of frames and covers flush with finish surface.
 - 3. Elsewhere, set tops 3" above finish surface unless otherwise indicated.
- B. Provide rubber joint gasket complying with ASTM C443.
- C. Apply bituminous mastic coating at joints of sections.

3.7 TRAP PRIMERS

- A. Install all trap primers and required distribution units as shown on plans and as required by manufacturers recommendations.

3.8 TRAP GUARDS

- A. Install elastomeric trap guards in specified floor and sink drains as indicated on plans.

END OF SECTION 22 10 00

SECTION 22 21 23 - NATURAL GAS SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish and Install:
 - 1. Natural gas piping.
 - 2. Valves and specialties.
- B. Gas Meter: The gas meter and piping upstream of meter will be provided by the Gas Utility Company and paid for by this Contractor.

1.2 SUBMITTALS

- A. Manufacturer's Product Data: Submit for:
 - 1. Gas cocks.
 - 2. Gas meter.
 - 3. Emergency shut-off valves and relays.
 - 4. Pressure reducing valves.

PART 2 - PRODUCTS

2.1 NATURAL GAS PIPING

- A. Above Ground:
 - 1. Two Inch and Smaller:
 - a. Pipe: Schedule 40 black steel.
 - b. Fittings: 150 lb. malleable iron, threaded.
 - 2. Over Two Inch:
 - a. Pipe: Schedule 40 black steel, plain end.
 - b. Fittings: Standard weight, butt weld.
 - 3. All piping within return air plenums or concealed (inaccessible) in building construction shall be as called for piping over 2".

B. Underground:

1. Pipe: Schedule 40 black steel, ASTM A53, Grade B, seamless, plain end.
2. Fittings: Standard weight, steel.
 - a. Two Inches and Smaller: Socket weld.
 - b. Over Two Inch: Butt weld.
3. Coating:
 - a. Pipe: AAPCA TGF-3.
 - b. Fittings: Protecto Wrap No. 200.
 - 1) Primer: No. 1170

2.2 GAS COCKS

- A. Description: Corrosion-resistant plug, permanently lubricated, corrosion-resistant bearings, suitable seals for intended service, lever operator.

2.3 PRESSURE REGULATING VALVES

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Actaris.
 - b. American Meter Company.
 - c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - d. Invensys.
 - e. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.

5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig (690 kPa).

C. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Actaris.
 - b. American Meter Company.
 - c. Eclipse Combustion, Inc.
 - d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - e. Invensys.
 - f. Maxitrol Company.
 - g. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 2 psig (13.8 kPa).

2.4 EMERGENCY GAS VALVES AND CONTROL STATIONS

- A. Control Station: ASCO No. 108D906, key operated to open switch, pushbutton to close with pilot light.
 - 1. Stainless-steel face plate for flush mounting.
 - 2. "GAS VALVE CONTROL" to be inscribed on the plate.
 - 3. Key switch labeled "ON".
 - 4. Pushbutton labeled "OFF".
- B. Valve: ASCO No. 8215, 2-way solenoid, 110-Volt, 60 Hz, AC.
 - 1. Normally closed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Remove cutting and threading burrs before assembling piping.
- B. Do not install defective piping or fittings.
- C. Do not use pipe with threads which are chipped, stripped or damaged.
- D. Use Teflon tape on male pipe threads.
- E. Plug each gas outlet, including valves with a threaded plug or cap, immediately after installation, and retain until continuing piping or equipment connection is completed.
- F. Do not install any valves or unions inside concealed areas or above ceiling in building.
- G. Vent gas PRVs outside the building in accordance with local code.
- H. Paint all exposed gas pipe with a minimum of 2 coats on rust resistant pipe.

3.2 BURIED PIPE

- A. Coated Pipe: Follow IAPMO Standard IS 13-84.
- B. Buried piping shall be buried 24" minimum.
 - 1. All buried joints shall be welded and left exposed until testing has been completed.

3.3 EMERGENCY SHUT-OFFS

- A. Install emergency shut-off valves where shown.
- B. Deliver switches and relays to Installer of electrical work.

3.4 TEST

- A. Prior to initial operation, test and purge fuel gas piping in accordance with local code requirements or the National Fuel Gas Code.
 - 1. Test at 65 psig minimum.
 - 2. Repair or replace piping as required to eliminate leaks, and re-test.

END OF SECTION 22 21 23

SECTION 22 30 00 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data for the following:

1. Domestic water heaters.
2. Domestic hot water storage tanks.
3. Pumps.
4. Sump Basins.
5. Startup report for gas fired heaters.
6. Warranty and service policies.

1.2 WARRANTY

A. Water Heater and Storage Tank:

1. Furnish a certificate of warranty outlining all specifics of heater manufacturer's warranty.
2. The warranty shall be a minimum of 5 years for all water heater products.
3. The heater shall have a first year service policy including labor, troubleshooting, and parts, all to be serviced by the manufacturer's representative.
4. Initiation and/or continuation of warranty coverage shall not be dependent upon annual inspections, regular replacement of anode rods, water chemistry, or rust.
5. Complete copies of all warranties and service policies, including all exclusions and conditions, shall be presented to the owner as part of the submittal package.

B. Burner and Heat Exchanger: The burner and all heater parts will have a one-year warranty. Heat exchanger and combustion chamber will have a 15-year warranty covering manufacturing or material defects, leaks, and/or the production of rusty water.

C. Storage Tanks:

1. Storage tanks shall have a 25-year warranty covering manufacturing or material defects, leaks, and/or the production of rusty water.

1.3 QUALITY ASSURANCE

A. The water heater will operate at a minimum thermal efficiency as scheduled when tested by an independent laboratory to ANSI Z21.10.3 (DOW 10 CFR 431). The water heater will comply with the current ASHRAE 90.1 requirements.

- B. The water heater will be constructed and stamped in accordance with Section IV, Part HLW of the ASME code and be National Board listed.
- C. All water heaters used in food service applications shall be NSF approved.
- D. Gas water heaters shall be compliant with ANSI Z.21.10.3 or UL 795.
- E. Water heaters shall be U.L, ETL or CSA certified as a complete unit.
- F. All components in contact with potable water shall comply with NSF standards.

PART 2 - PRODUCTS

2.1 GAS FIRED WITH INTEGRAL STORAGE TANK

- A. Manufacturers:
 - 1. Acceptable Manufacturers:
 - a. A.O. Smith
 - b. Bradford White
 - c. Hubbell
 - d. PVI Industries, LLC
 - e. Ruud-Rheem
 - f. State
- B. Construction:
 - 1. Water heaters will be of the BTU input(s) and storage capacity indicated on the equipment schedule.
 - 2. The water heater will be a vertical fire tube, design that is constructed and stamped in accordance with Section IV, Part HLW of the ASME code. Water heater will be National Board Registered for a working pressure of 150 psi and will be pressure tested at 1-1/2 times working pressure.
 - 3. Water heater will be a down-fired, fire tube design contained within an integral storage tank.
 - 4. Tank, combustion chamber and fire tubes will be unlined. Lined or plated water heaters will NOT be acceptable.
 - 5. Tank, combustion chamber and fire tubes will be constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923 Methods A to ensure that the product is free of detrimental chemical precipitation that affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride cracking test protocols as defined in ISO 3651-2 and ASTM G123 - 00(2005) "Standard

Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution.”

6. Tank will be welded utilizing joint designs to minimize volume of weld deposit and heat input. All heat affected zones (HAZ) shall be processed after welding to ensure the HAZ corrosion resistance is consistent with the mill condition base metal chemical composition. Weld procedures (amperage, volts, welding speed, filler metals and shielding gases) utilized shall result in a narrow range of austenite-ferrite microstructure content consistent with phase balanced objectives for welds, HAZ and the base metal.
7. All internal and external tank surfaces shall undergo full immersion passivation and pickling processing to meet critical temperature, duration and chemical concentration controls required to complete corrosion resistance restoration of pressure vessel surfaces. Other passivation and pickling methods are not accepted. Immersion passivation and pickling certification documents are required and shall be provided with each product.
8. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. Storage tank materials shall contain more than 80% post-consumer recycled materials and be 100% recyclable.
9. All water contacting tank surfaces will be non-porous and exhibit 0% water absorption.
10. All tank connections/fittings will be non-ferrous or stainless steel.
11. To preserve thermal efficiency, the water heater will not use or require a circulator piped from the hot water outlet to the cold-water inlet of the heater for the purpose of temperature control during normal operation. Connection for a building return circulation line will be made to a dedicated hot return fitting at the center of the storage vessel and not the cold inlet piping. Connection to a sidearm tank, if used, will be made to a dedicated hot return fitting at the center of the storage vessel and not the cold inlet piping.
12. Finished vessel will NOT require sacrificial or impressed current anodes and none will be used. Water heaters or sidearm storage tanks that employ anode rods of any type will NOT be acceptable.
13. Combustion will be provided by a premix, fan-assisted surface burner with a gas train meeting UL, ANSI and FM standards for the input specified.
14. Burner will be stainless steel.
15. Gas train components will be capable of self-proportionating gas and air to maintain optimum combustion in response to varying vent pressures.
16. At 199,000 to 399,000 BTU input, the burner will be fixed input.
17. At 500,000 BTU input and higher, the burner will employ non-linkage modulation utilizing only a VFD drive to vary gas and air.
18. Burner NOx emissions will be less than 20 ppm when corrected to 3% oxygen.
19. Water heater will be a category IV, condensing appliance and vent through PVC or Polypropylene. Water heater will satisfy requirements for sealed combustion. Vents for inlet air and exhaust can terminate in different pressure zones.

2.2 PERFORMANCE

- A. Water heater will meet the thermal efficiency and standby heat loss requirements of the latest version of the ASHRAE 90.1 standard.

- B. Water heater will be certified by the DOE/EPA Energy Star program for commercial water heaters, whereby standby loss and thermal efficiency are independently tested and certified.
- C. Water heater will be third party tested and certified to NSF 5.
- D. Water heaters will be third party tested and certified to NSF/ANSI 372 standard for lead content.

2.3 WATER HEATER TRIM

- A. As a minimum, the heater will be equipped with the following:
 - 1. electronic flame monitoring
 - 2. electronic low water cutoff
 - 3. an immersion operating control
 - 4. an immersion UL listed temperature limiting device
 - 5. an ASME- rated temperature and pressure relief valve
- B. Operating and safety controls shall meet the requirements of UL 795 and FM
- C. The water heater shall employ an electronic operating control with digital temperature readout. Operator shall be capable of connecting to a building automation system through serial connection using Modbus RTU protocol.

2.4 ELECTRIC WATER HEATER (LIGHT DUTY)

- A. Manufacturers:
 - 1. Acceptable manufacturers:
 - a. A.O. Smith
 - b. Bradford White
 - c. Rheem
 - d. Rudd
 - e. State
- B. General:
 - 1. Water heater to be light commercial grade complying with standby loss requirements of the U.S. Department of Energy and current edition of ASHRAE/IESNA 90.1. Heaters to comply with NSF/ANSI 61 and NSF 372 for lead free requirements.
 - 2. Water Heater volume, input capacity, recovery and voltage to be as scheduled on the Drawings.

C. Construction:

1. The storage tank shall be glass lined insulated with baked enamel finish. Tank to be capable of an operating pressure of 150 Psig.
2. Tank shall be equipped with a ball-type drain valve.
3. Elements to be medium watt density with zinc plated copper sheaths.
4. Tank to be provided with an ASME rated Temperature and Pressure Relief Valve.
5. Tank to have anode rod corrosion protection.

D. Warranty:

1. The water heater components to carry a minimum three-year warranty from defects.

2.5 GAS FIRED WATER HEATER (LIGHT DUTY, STORAGE TYPE, CONDENSING)

A. Manufacturers:

1. Acceptable Manufacturers:
 - a. A.O. Smith
 - b. Bradford White
 - c. Rheem
 - d. Rudd
 - e. State Industries

B. General:

1. Water heater to be light commercial condensing gas type with sealed combustion chamber complying with standby loss requirements of the U.S. Department of Energy and current edition of ASHRAE/IESNA 90.1. Heaters to comply with NSF/ANSI 61 and NSF 37 for lead free requirements. Heater to be certified to ANSI Z21.10.3-CSA-4.3 standard.
2. Water Heater volume, input capacity, recovery, thermal efficiency and voltage to be as scheduled on the Drawings.

C. Construction:

1. The storage tank shall be glass lined insulated with baked enamel finish. Tank to be capable of an operating pressure of 150 Psig.
2. Tank shall be equipped with a ball-type drain valve.
3. Modular blower to include a built-in safety device to prevent main burner operation if blower is not operating. Blower to have 120V/1 PH control connection. A hot surface ignitor to initiate operation without a standing pilot.
4. Heater to be capable of direct venting utilizing PVC, CPVC or stainless-steel material for both exhaust and combustion air.

5. Tank to be provided with an ASME rated Temperature and Pressure Relief Valve.
6. Tank to have anode rod corrosion protection.

D. Warranty:

1. The water heater tank to carry a minimum three-year warranty and components with a one-year warranty from defects.

2.6 PUMPS

A. General:

1. Statically and dynamically balance rotating parts.
2. Construction shall permit complete servicing without breaking piping or motor connection.
3. Pumps operate at 1750 rpm unless scheduled otherwise.
4. Pump connections shall be flanged.
5. For duplex sump pumps/sewage ejectors provide a remote-mounted alternating panel.

B. In-Line Circulating Pumps:

1. Manufacturers:

- a. Design Basis: Bell & Gossett.
- b. Other Acceptable Manufacturers:
 - 1) Armstrong
 - 2) Taco

2. Description:

- a. Type: In-line circulating pumps.
 - b. Casing: Bronze for 125 psi working pressure.
 - c. Impeller: Bronze.
 - d. Shaft: Steel with copper sleeve or stainless steel.
 - e. Bearings: Oil lubricated, bronze, sleeve.
 - f. Seal: Carbon rotating against a stationary ceramic seat, rated for 225°F.
3. Pump components in contact with domestic water system shall meet the requirements of NSF/ANSI Standard 61.

C. Sump Pumps - Submersible Type:

1. Manufacturers:

- a. Design Basis: Weil.
- b. Other Acceptable Manufacturers:
 - 1) Aurora
 - 2) Hydromatic
 - 3) Pacific
 - 4) Swaby

2. Pump: Submersible Type, designed for use in submerged applications

- a. Motor Type: NEMA 6, Air Filled, Class F Insulation, Oil filled not accepted
- b. Temp Limiter: Motor shall include a Temperature Limiter
- c. Motor Shell: Cast iron, finned on 5 hp and larger, with lifting handle
- d. Shaft: Solid 316 Stainless steel, Shaft Sleeves are not acceptable
- e. Power Cable: Neoprene jacket, 20' minimum in length
- f. Motor Cover: Includes cable sealing system to prevent water entry
- g. Bearings: Double-sealed and permanently lubricated ball bearings
- h. Seal: Mechanical up to 3 hp, Tandem Mechanical required for 5hp plus
- i. Sensor: Moisture Sensor and Temp Limiter required on 5 hp and above
- j. Operation: Up to 150° F intermittent duty and 120° F for continuous duty
- k. Thermal: Motors shall include built-in thermal overload protectors
- l. Impeller: Heavy Duty ASTM A48-83 Cast iron
- m. Hardware: All external hardware shall be 304 stainless steel

3. Removal System

- a. Removal: Removal and reinstallation without disturbing discharge piping
- b. Connection: Metal to metal connection on pump to floor elbow
- c. Construction: Base Elbow and Sliding Bracket to be ASTM A48-83 Cast Iron

4. Control: Control Panel with Tethered Float Switches

- a. Control Panel
 - 1) UL Listed Label
 - 2) NEMA 4 Enclosure
 - 3) TEST-OFF-AUTO switch for each pump
 - 4) Automatic Alternation after each cycle
 - 5) Through-the-door disconnect
 - 6) High Water Alarm (HWA) with 95dB horn and silence button
 - 7) Indicator Lights For: Control Power, Pump Run, High Water, Overload
 - 8) Fused Control Transformer

- 9) Overload Protection
- 10) Moisture Sensor and Temp Limiter Circuits on 5 HP and greater
- 11) One set each of dry contacts for monitoring: HWA & Pump Run
- 12) Hour Meter for each pump
- 13) Configure for Off/Stop, Lead/Start, Lag/Standby and High Water Alarm

b. Tethered Floats

- 1) Provide mercury tethered float switches

D. Sump Pumps - Vertical Pedestal Type:

1. Manufacturers:

- a. Design Basis: Weil.
- b. Other Acceptable Manufacturers:

- 1) Aurora
- 2) Hydromatic
- 3) Pacific
- 4) Swaby

2. Motor: Totally Enclosed Fan-Cooled (TEFC), Flexible Coupling

3. Shaft: 416 Stainless steel

4. Bearings:

- a. Thrust: Sealed Ball Bearing
- b. Upper: Bronze Sleeve Bearing
- c. Intermediate: Cast Iron Housing with Grease lubricated bronze sleeve bearing
- d. Lower: Grease lubricated bronze sleeve bearing

5. Casing: Cast Iron

6. Impeller: Heavy Duty ASTM A48-83 Cast iron

7. Pump Legs: Galvanized

8. Control: Control Panel with Mechanical Lever

a. Control Panel

- 1) UL Listed Label
- 2) NEMA 4 Rated Enclosure or
- 3) TEST-OFF-AUTO switch for each pump
- 4) Automatic Alternation after each cycle
- 5) Through-the-door disconnect
- 6) High Water Alarm (HWA) with 95dB horn and silence button
- 7) Indicator Lights For: Control Power, Pump Run, High Water, Overload
- 8) Fused Control Transformer
- 9) Overload Protection

- 10) One set each of dry contacts for monitoring: HWA & Pump Run
- 11) Hour Meter for each pump
- 12) Configure for Off/Stop, Lead/Start, Lag/Standby and High Water Alarm

b. Mechanical Lever

- 1) Provide Mechanical Lever Float Switch
 - a) Stainless-Steel Float Rod and Float Ball
 - b) Adjustable stops

9. Cover:

- a. Material: Steel with openings and studs for mounting floor plates of pumps
- b. Sump Diameter: See Schedule

E. Sewage Ejectors - Submersible Type:

1. Manufacturers:

- a. Design Basis: Weil
- b. Other Acceptable Manufacturers:
 - 1) Aurora
 - 2) Hydromatic
 - 3) Pacific
 - 4) Swaby

2. Pump: Submersible Type, designed for use in submerged applications

- a. Motor Type: NEMA 6, Air Filled, Class F Insulation, Oil filled not accepted
- b. Temp Limiter: Motor shall include a Temperature Limiter
- c. Motor Shell: Cast iron, finned on 5 hp and larger, with lifting handle
- d. Shaft: Solid 316 Stainless steel, Shaft Sleeves are not acceptable
- e. Power Cable: Neoprene jacket, 20' minimum in length. Coordinate with panel location.
- f. Motor Cover: Includes cable sealing system to prevent water entry
- g. Bearings: Double-sealed and permanently lubricated ball bearings
- h. Seal: Mechanical up to 3 hp, Tandem Mechanical required for 5hp plus
- i. Sensor: Moisture Sensor and Temp Limiter required on 5 hp and above
- j. Operation: Up to 150° F intermittent duty and 120° F for continuous duty
- k. Thermal: Motors shall include built-in thermal overload protectors
- l. Impeller: Heavy Duty ASTM A48-83 Cast iron, 2" Solids Handling
- m. Hardware: All external hardware shall be 304 stainless steel

3. Removal System

- a. Removal: Removal and reinstallation without disturbing discharge piping
- b. Connection: Metal to metal connection on pump to floor elbow
- c. Construction: Base Elbow and Sliding Bracket to be ASTM A48-83 Cast Iron

4. Control: Control Panel with Tethered Float Switches

a. Control Panel

- 1) UL Listed Label
- 2) NEMA 4 Enclosure
- 3) TEST-OFF-AUTO switch for each pump
- 4) Automatic Alternation after each cycle
- 5) Through-the-door disconnect
- 6) High Water Alarm (HWA) with 95dB horn and silence button
- 7) Indicator Lights For: Control Power, Pump Run, High Water, Overload
- 8) Fused Control Transformer
- 9) Overload Protection
- 10) Moisture Sensor & Temp Limiter Circuits on 5 HP and greater
- 11) One set each of dry contacts for monitoring: HWA & Pump Run
- 12) Hour Meter for each pump
- 13) Configure for Off/Stop, Lead/Start, Lag/Standby and High Water Alarm.

b. Tethered Floats

- 1) Provide mercury tethered float switches

F. Oil-Minder Sump Pumps (Elevator Pits):

1. Manufacturers:

- a. Design Basis: Stancor
- b. Other acceptable manufacturers:
 - 1) Weil

2. Provide pump and control systems capable of pumping water while containing oil. The system shall function automatically and shall provide for an alarm and separate LED lights in the event of:

- a. The presence of oil in the sump
- b. High liquid in the sump, or
- c. High amps or a locked rotor condition.

3. LED lights shall be provided for:
 - a. Power
 - b. Pump run function.
4. Pump:
 - a. The pump shall be a submersible type, capable of pumping up to 37' TDH and 74 GPM.
 - b. The pump shall be approved to UL 778 standards and shall include thermal and overload protection.
 - c. The motor shall be rated ½ H.P., 1 phase, 115V and capable of operating continuously or intermittently.
 - d. The motor housing shall be constructed of #304 stainless steel and mechanical seats shall be housed in a separate oil-filled compartment.
5. Control:
 - a. The main control shall be approved to UL 508 standards and housed in a gasketed NEMA 4X enclosure with a see-through window for observation of operating functions.
 - b. The control shall be equipped with an 8-pin twist lock receptacle, dual solid-state Oil-Minder relays with variable sensitivity settings, an over current relay, self-cleaning stainless-steel sensor probe, high decibel warning horn with alarm silencing switch, dual floats, clearly marked terminal board and remote monitoring contact.
 - c. A NEMA 4X junction box with 8-pin twist-lock electrical receptacle and 25' (additional lengths available in 25' increments) of mating 8 conductor cable shall be provided.
 - d. All cables between the pump and junction box shall be 16' long and the cable and plug from the control unit shall be 8' long.
 - e. The control unit, junction box, pump, floats and sensor shall be factory assembled as a complete, ready-to-use system and shall be tested and approved as a complete system by a nationally recognized testing laboratory.
 - f. The system shall allow for the main control to be located outside of the elevator hoistway to be monitored for all functions without having to enter the elevator shaft.

G. Sump Basins:

1. Precast concrete (refer to detail).
2. Fiberglass reinforced polyester
 - a. Acceptable Manufacturers:
 - 1) AK Industries.
 - 2) Fiberbasin Incorporated.
 - 3) Topp Industries.
 - b. Minimum Wall Thickness:
 - 1) At Flange: 1/2"
 - 2) At Hubs: 3/8"
 - 3) Other Areas: 3/16"
 - 4) Top flange to be extended for support to suspend unit from structural slab.
 - c. Connections: To accommodate piping shown on drawings.
 - d. Cover Attachment: Tapped bronze inserts in flange for bolt down cover.
 - e. Size: As shown on drawings, or, if not shown, of size determined by pump manufacturer.
 - f. Basin Cover:
 - 1) Material: Steel or Aluminum
 - 2) Provision for Lifting: Ring or handle.
 - 3) Cut-Outs: For removal of cover without disturbing piping or wiring.
 - 4) H2O loading for traffic areas.

2.7 INSTANTANEOUS POINT-OF-USE ELECTRIC WATER HEATER

A. Acceptable Manufacturers:

1. Chronomite
2. Eemax
3. Hubbell
4. PVI

B. Construction and Accessories:

1. Stainless-steel heating elements.
2. Built-in temperature shutoff at 190 degrees.
3. 0.5 GPM inline flow control fitting.
4. Flow switch activated at 0.4 GPM and shutoff at 0.3 GPM

PART 3 - EXECUTION

3.1 DOMESTIC HOT WATER HEATER

A. Installation:

1. Make connections between water heaters and domestic water piping system with dielectric unions.
2. Install isolation valves at both cold water and hot water connections to water heater.
3. Furnish and install copper drain piping from temperature and pressure relief valve for water heater.
 - a. Furnish drain full size of relief valve opening and extend as indicated.
4. Install condensate neutralizer on all condensing water heaters. Route discharge from condensate neutralizer to approved receptor.
5. Water heaters installed in office tenant spaces and residential units to have galvanized drip pans with drains installed beneath the tanks.

B. Adjusting:

1. Provide start-up and adjustment by factory authorized personnel. A copy of the start up report will be provided to the owner.
2. Provide equipment video on manufacturer's website which covers, startup, equipment controls, and operation, for later use by the owner.
3. Upon completion of water heater installation, verify satisfactory control operation under maximum demand conditions as recommended by manufacturer.
4. Adjust discharge water temperature as required. Make control adjustments required.

3.2 IN LINE CIRCULATING PUMPS

- A. Install pumps to allow complete removal without dismantling connecting piping. Provide air cock and drain connection on horizontal pump casings.
- B. Provide line sized gate valve and strainer on suction and line sized soft seated check valve and globe valve or plug valve on discharge.
- C. Support pump and piping so that weight of pipe is not carried on pump casing. Additionally, support such that neither pump nor piping is supported by associated equipment.
- D. Provide manual switch and aquastat where required.
- E. Verify motor position is in accordance with manufacturer's installation instructions.

3.3 HEAT TRACE

- A. Install self-regulated heater and components on domestic hot water supply piping mains and risers as indicated in the plans and specifications after the piping has been pressure tested, but before the thermal insulation is applied. Secure the heater to piping with Raychem GT-66 fiberglass tape.
- B. Apply “electric traced” signs to the outside of the thermal insulation.
- C. After installation and before and after installing the thermal insulation, test heater using a 1000 VDC megger. Minimum insulation resistance should be between 20 and 1000 megohms regardless of length.

3.4 SUMP PUMPS

- A. Provide union in discharge piping above floor.
- B. Provide gate valve above floor.
- C. Provide lift check valve close to pump discharge.
- D. Install and adjust float control.
- E. Manufacturer’s Representative to be present for Start-Up and provide test report. Test pump staging and float operation by flooding pit to simulate operation. Test shall be observed by Engineer or Owner Representative.
- F. Elevator Sump Pump Control Panels – Panels will be located out from high end spaces. Coordinate location and provide additional controls and power cables as required.

END OF SECTION 22 30 00

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Submit manufacturer's product data for plumbing fixtures and accessories, in accordance with Division 1.
- B. LEED Submittals: Credit WE 3.1 and 3.2: Product Data for plumbing fixtures indicating water consumption.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All manufacturers are listed in alphabetical order and not by preference.
- B. Provide factory fabricated fixtures.
- C. Provide trim, carriers, valves and accessories as required for complete installation.
- D. All carriers are floor mounted unless otherwise noted. All carriers shall be bolted down to floor structure.
- E. Refer to Drawings for "Plumbing Fixture Schedule".
- F. Comply with Local, State and Governing ordinances concerning maximum water requirements of plumbing fixtures: Tank type W.C. and flush valve type W.C. = 1.28 gal./flush; lavs = .5 GPM; urinals = 1.0 (.5 or .125) gal./flush and showers = 1.5 gal. maximum.
- G. All valves, fixtures and accessories in contact with domestic water shall meet the requirements of NSF/ANSI Standard 61. Exception includes toilets, bidets, etc.

2.2 PLUMBING FIXTURES

- A. Acceptable Manufacturers:
 - 1. Water Closets, Urinals, Lavatories:
 - a. American Standard
 - b. Kohler

- c. Sloan
- d. Toto
- e. Zurn

2. Faucets:

- a. American Standard
- b. Cambridge Brass
- c. Chicago
- d. Delta
- e. Kohler
- f. Moen
- g. Sloan
- h. Symmons
- i. Toto
- j. Zurn

3. Flush Valves

Diaphragm Type

- a. Sloan
- b. Zurn

Piston Type Flush Valves

- c. Kohler
- d. Sloan
- e. Toto
- f. Zurn

B. Water Closets:

- 1. Unless otherwise specified, all water closets are vitreous china water saver type, white.
- 2. All flush valves, stops and supplies are to be chrome plated brass. Flush valves to be non hold open type. See section 2.3.

C. Urinals:

- 1. Unless otherwise specified, all urinals are vitreous china water saver type, white.
- 2. All flush valves are to be chrome plated brass, non hold open. See section 2.3.

D. Lavatories:

- 1. Unless otherwise specified, all lavatories are white.
- 2. Provide chrome plated brass angle stops, supplies, tail piece, P trap and grid strainer for all lavatories.
- 3. Provide offset P traps on all ADA lavatory installations.

2.3 FLUSH VALVES

- A. Exposed diaphragm type, chrome plated flush valve. Valves will have paraflow diaphragm kit for flush discharge adjustment. Valve will be a non-hold open, and have no external volume adjustment. Valve will have ADA compliant handle, back check control stop will have a sweat solder adapter kit with cast set screw with flange. Valve body, cover, tailpiece and control stop will be in conformance with ASTM alloy classification. Valve will be in compliance with applicable sections of ASSE 1037 and ANSI A117.1 requirement for people with disabilities.

2.4 WATER CLOSET SEATS

- A. Acceptable Manufacturers:
 - 1. Beneke
 - 2. Centoco
 - 3. Church
- B. Construction: Unless otherwise specified seats shall be heavy duty solid plastic, white with open front, concealed self-sustaining check hinge less cover. Seat shall have an antimicrobial compound as an integral part of the plastic and shall match shape of bowl (elongated or regular).

2.5 MOP SINK BASIN

- A. Manufacturers:
 - 1. Design Basis: See "Plumbing Fixture Schedule" on drawings.
 - 2. Other Acceptable Manufacturers:
 - a. Fiat Products
 - b. Mustee
 - c. Stern Williams
- B. Material: Terrazzo or Molded Stone
- C. Mount: Floor
- D. Faucet: Chrome plated with vacuum breaker, integral check valves, pail hook and wall brace.
- E. Drain: Stainless steel, flat strainer, 3" IPS.

2.6 SHOWER VALVES

- A. Acceptable Manufacturers:
 - 1. American Standard
 - 2. Bradley
 - 3. Cambridge Brass
 - 4. Chicago
 - 5. Delta
 - 6. Kohler
 - 7. Leonard
 - 8. Speakman
 - 9. Symmons
- B. Features: Single handle, automatic pressure and temperature balancing, and volume control, forged brass body with ceramic valving, adjustable temperature stop and polished chrome handle.
- C. Handheld shower to be non-positive control to comply with ADA and shall be equipped with either an integral check valve or a vacuum breaker.
- D. Heads and Arm: Polished chrome plated brass.
- E. Shower valves shall turn off from hot to cold.

2.7 STAINLESS-STEEL SINKS

- A. Acceptable Manufacturers:
 - 1. Elkay
 - 2. Kohler
 - 3. Just
- B. Material: 18-gauge, type 304, stainless steel.
- C. Mounting: Countertop, self-rimming.
- D. Trap: 1½" adjustable, cast brass.
- E. Stops: Loose key, ½" FPT, flexible supply, flange.
- F. Provide chrome plated brass tailpiece and grid strainer.
- G. ADA accessible sinks shall not exceed 6 ½" in depth.

2.8 GARBAGE DISPOSER

A. Acceptable Manufacturers:

1. In-Sink-Erator
2. Kitchenaid
3. Maytag
4. Waste King

B. Features:

1. Continuous feed.
2. Stainless sink flange.

2.9 FLOOR SINK

A. Acceptable Manufacturers:

1. Josam
2. JR Smith
3. Wade
4. Watts Ancon
5. Zurn

B. Body: Cast iron with acid-resisting porcelain enameled interior.

C. Rim and Grate: Nickel bronze

D. Provide with clamping collars with waterproof membrane clamps

2.10 FLOOR DRAINS

A. Acceptable Manufacturers:

1. Josam
2. JR Smith
3. Wade
4. Watts Ancon
5. Zurn

B. Body: Duco cast iron, with flashing collar.

C. Grates and sediment strainers as specified in schedule.

- D. Provide primer taps as specified in schedule.
- E. Provide with clamping collars with waterproof membrane clamps.

2.11 ELECTRIC WATER COOLERS

- A. Acceptable Manufacturers:
 - 1. Cordley
 - 2. Elkay
 - 3. Halsey Taylor
 - 4. Haws
 - 5. Oasis
 - 6. Sunroc
- B. Industry Standards: Provide water coolers with UL and ARI labels, and which meet or exceed standards of the Safe Drinking Water Act and Lead Contamination Control Act, NSF Standard 61, Section 9. (Proposition 65 in California.) All components in the waterway to be lead free.
- C. Evaporator and Chiller: All copper construction.
- D. Accessories:
 - 1. Automatic pressure regulator.
 - 2. Stop and supply.
 - 3. Cast brass P-trap.
 - 4. Provide bottle filler when indicated.
 - 5. Front push button activation.
 - 6. Removable grid strainer.
 - 7. Required mounting frame.
 - 8. Bottle filler.
- E. Finish: Heavy gauge stainless steel with No. 4 satin finish.
- F. Units to meet all NSF and ADA standards.

2.12 DRINKING FOUNTAINS

- A. Acceptable Manufacturers:
 - 1. Cordley
 - 2. Elkay
 - 3. Halsey Taylor
 - 4. Haws

5. Oasis
 6. Sunroc
- B. Industry Standards: Provide drinking fountains and/or cuspidor which meet or exceed standards of the Safe Drinking Water Act and Lead Contamination Control Act, NSF Standard 61, Section 9. (Proposition 65 in California.) All components in the waterway to be lead free.
- C. Accessories:
1. Automatic pressure regulator.
 2. Stop and supply.
 3. Cast brass P-trap.
 4. Provide bottle filler when indicated.
 5. Front push button activation.
 6. Removable grid strainer.
 7. Required mounting frame.
 8. Bottle filler.
- D. Finish: Heavy gauge stainless steel with No. 4 satin finish.
- E. Units shall meet all NSF and ADA standards.

2.13 WASHING MACHINE WALL BOX

- A. Acceptable Manufacturers:
1. Guy Gray
 2. IPS
 3. Symmons
- B. Material: Brass.
- C. Connections:
1. ½" CW and HW with shock arrestors. (Supplies from top or bottom as indicated.)
 2. 2" drain.

2.14 WASH FOUNTAINS

- A. Acceptable Manufacturers:
1. Acorn
 2. Bradley

B. Accessories:

1. Precast terrazzo bowl.
2. Supplies as noted on drawings.
3. Centrally rising vent.
4. P trap.
5. Foot control – sectional.
6. Liquid soap dispenser.
7. Color, Granite (to be verified by Architect).
8. Thermostatic mixing valve.
9. Standard vinyl clad straight pedestal panels.

2.15 EQUIPMENT FURNISHED UNDER OTHER SECTIONS

- A. Provide all materials necessary to make final connections to owner equipment furnished under other Sections of these Specifications including:
1. Tail pieces
 2. Stops
 3. Supplies
 4. P traps, standard and/or offset
 5. Escutcheons

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install each fixture with P trap with cleanout plug, easily removable for servicing and cleaning.
- B. Provide chrome plated, rigid or flexible supplies to fixtures with stops, reducers and escutcheons.
- C. Finish wall and floor penetrations when exposed to view in finished areas with set screw type, chrome plated brass escutcheons.
- D. Set plumbing fixtures level and plumb, spaced in accordance with architectural dimensioned drawings, and securely install to be rigid.
- E. Install wall-mounted lavatories, urinals and water closets with wall carriers mounted to the floor.
- F. Solidly attach floor-mounted carriers for all fixtures to floor using proper fasteners based on floor construction.

- G. Cover fixture bolts with china bolt caps of the same color where required.
- H. All wall-mounted fixtures to be caulked between fixture and wall.
- I. Securely anchor flush valves behind or within walls to be rigid and not subject to movement due to push or pull action on the valve.
- J. Fixture Mounting Heights:
 - 1. Refer to Architectural drawings and ADA standards.
- K. Floor Drains:
 - 1. Refer to Architectural drawings for exact locations and additional installation requirements.
 - 2. Install floor drains with P-traps and vent as required.
 - 3. Install drains on the center line of sheet lead pan and/or membrane in waterproofed areas and in floors above lowest floor.
 - 4. Clamp pan and/or membrane into drain flashing collar.
 - 5. Install strainers immediately after completion of finish floor installation.
 - 6. Coordinate locations with mechanical equipment.
 - 7. Install trap primers as indicated.
- L. All exposed piping serving plumbing fixtures that may be used for ADA purposes shall have traps and supplies insulated per ADA requirements.
- M. Install flushing mechanism for both ADA accessible flush valves and flush tanks to the side of water closet that has the most floor space per ADA requirements. Provide for ADA prescribed clearances between the top of the flush valve and grab bars.
- N. Provide a tempering valve that conforms to ASSE 1070 for all lavatories and sinks used as a public hand wash facility.

3.2 ADJUSTING AND CLEANING

- A. Cleaning:
 - 1. Clean strainers, traps, aerators, and valves of debris, sand and dirt.
 - 2. At completion, thoroughly clean plumbing fixtures and equipment.
- B. Adjusting: After cleaning and flushing operations are accomplished, adjust flush valves, faucets, showers, bubblers for proper flow.

3.3 PROTECTION

- A. Protect fixtures and related components from damage before, during, and after installation to date of Final Acceptance or Owner move-in. Provide protective coverings or other protection as required.
- B. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit.
- C. Feasibility and match to be judged by Architect or Engineer.
- D. Remove cracked or dented units and replace with new units.
- E. Contractor shall be responsible for replacing damaged fixtures or components.

END OF SECTION 22 40 00

SECTION 22 90 00 - PLUMBING PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 REFER TO RELATED SECTIONS

- A. Section 23 90 00 – Project Closeout

PART 2 - NOT USED

PART 3 - NOT USED

END OF SECTION 22 90 00

SECTION 23 05 01/26 05 01 - MECHANICAL AND ELECTRICAL COORDINATION

PART 1 - GENERAL

1.1 RESPONSIBILITY

- A. The Divisions 21 through and 26 through 28 contractor(s) shall comply with the provisions of this section. The Divisions 21 through 23 contractor(s) shall verify electrical service provided by the electrical contractor before ordering any mechanical equipment requiring electrical connections. Provide submittals of all mechanical equipment to Division 26 through 28 contractor(s).
- B. The final responsibility for properly coordinating the electrical work of this section shall belong to the Divisions 21 through 23 system contractor performing the work, which requires the electrical power.
 - 1. Each Divisions 21 through 23 contractor shall be responsible for providing power wiring for certain devices as described in the specifications and on the drawings. This work shall be provided by a licensed electrician in accordance with all of the applicable provisions of the Division 26 through 28 specifications, NEC and local codes.

1.2 WORK INCLUDED

- A. Carefully coordinate the interface between Divisions 21 through 23 (Mechanical) and Divisions 26 through 28 (Electrical), and Division 23 09 00 (Building Management and Automatic Temperature Control Systems) before submitting any equipment for review or commencing installation

1.3 DEFINITIONS

- A. Automatic: Pertaining to a function, operation, process or device that, under specified conditions, functions without intervention by human operator.
- B. Disconnect Switch: A mechanical switching device used for changing the connections in a circuit, or for isolating a circuit or equipment from a power source.
- C. Motor Control Center: A floor-mounted assembly of one or more enclosed vertical sections having a common horizontal power bus and primarily containing motor starting units.
- D. Control Circuit/Power: The circuit which carries the electrical signals of a control apparatus or system directing the performance of the controller but does not carry the main power circuit.
- E. Manual Operation: Operation by hand without the use of any other power.

- F. MC: Mechanical Contractor = Divisions 21 through 23 Contractor who furnishes motor.
- G. TC: Temperature Controls = Division 23 09 00 Contractor who furnishes control.
- H. EC: Electrical Contractor = Divisions 26 through 28 Contractor.
- I. FA: Fire Alarm Contractor = Division 28 Contractor who furnishes Fire Alarm System.
- J. IPC: Ice Plant Contractor = Contractor who furnishes the Ice Plant System.
- K. EP: Electric to Pneumatic Converter.
- L. PE: Pneumatic to Electric Converter.

1.4 RESPONSIBILITY SCHEDULE

- A. Responsibility: Unless otherwise indicated, all motors and controls for Divisions 21 through 23 equipment shall be furnished, set in place and wired in accordance with the following schedule:

ITEM -	Furnished Under	Set In Place Under	Power Wiring Under	Control Wiring Under
MC: Mechanical Contractor TC: Temperature Contractor EC: Electrical Contractor FA: Fire Alarm Contractor				
AHU Interior Marine Lights	MC	MC	EC	MC
Equipment Motors	MC	MC	EC	--
Automatically or Manually Controlled Starters/Contactors: (Note 4)				
-Separate	MC	EC	EC	TC
-Factory Mounted and Wired	MC	MC	EC	TC
In Motor Control Centers (Note 4)	EC	EC	EC	TC
Motor Speed Controllers: (Note 4)				
-Separate	MC	EC	EC	TC
-Factory Mounted and Wired	MC	MC	EC	TC
Disconnect Switches (Note 1)	EC	EC	EC	--
Thermal Overload Switches (Note 1)	EC	EC	EC	--
Switches (Manual or Automatic other than disconnect) (Note 2)	MC or TC	MC or TC	EC or TC	TC or MC
Control Relays (Note 2)	MC or TC	MC or TC	--	TC
Control Transformers	MC or TC	MC or TC	EC or TC	TC
Push Button Stations, Pilot Lights	MC	EC	EC	EC
Thermostat and Controls: Integral with Equipment or Directly Attached to Ducts, Pipes, etc. (Note 2)	MC or TC	EC or TC	EC or TC	TC
Equipment in Temperature Control Panels	TC	TC	TC	TC

ITEM -	Furnished Under	Set In Place Under	Power Wiring Under	Control Wiring Under
MC: Mechanical Contractor TC: Temperature Contractor EC: Electrical Contractor FA: Fire Alarm Contractor				
Standalone Control Panels (BAS) (Note 6)	TC	TC	TC	TC
Valve Motors, Damper Motors, Solenoid Valves, etc.	TC	TC	TC	TC
EP Valves or Switches, P.E. Switches, etc.	TC	TC	--	TC
Fire Alarm System (Note 3)	FA	FA	EC	FA
Fire Sprinkler Alarm (Note 3)	MC	MC	EC	FA
Duct System Smoke Detectors (Note 5)	FA	MC	--	TC/FA
Relays for Fan Control via duct detectors (Note 5)	MC	MC	EC	TC
Room Smoke Detectors Including Relays for Fan Control (Note 3)	FA	FA	--	FA
Smoke Management Controls (Note 7)	FA	FA	EC	FA
CO Sensors	TC	TC	TC	TC
Control Air Compressor	TC	TC	TC	TC
Refrigerated Air Dryer	TC	TC	TC	TC
Equipment Interlocks	TC	TC	--	TC
Fire/Smoke and Smoke Dampers (Note 7)	MC	MC	EC	FA
Smoke Control Dampers (for smoke management system)	MC	MC	EC	FA/TC
Positive Indication Devices (i.e., current sensors, end switches, airflow sensors)	TC	TC	--	FA/TC
Heat Trace Systems (Note 8)	MC	MC	MC	MC
Ice Plant Equipment (other than outdoor condensing unit)	IPC	IPC	IPC	IPC
Ice Plant Outdoor condensing unit.	IPC	IPC	EC	IPC
Ice plant Motor Control Center (Note 9)	IPC	IPC	IPC	IPC

Notes:

1. If furnished as part of factory wired equipment furnished and set-in place by MC, wiring and connections by EC.
2. If float switches, line thermostats, P.E. switches, time switches, or other controls carry the FULL LOAD CURRENT to any motor, they shall be furnished by MC, but they shall be set in place and connected by EC, except that where such items are an integral part of the mechanical equipment, or directly attached to ducts, piping, or other mechanical equipment, they shall be furnished and set-in place by MC and connected by EC. If they

do not carry the FULL LOAD CURRENT to any motor, they shall be furnished, set in place and wired by TC contractor.

3. Pre-action system initiation signals (such as smoke detectors or general alarm conditions in a pre-action zone) shall be provided under Division 28.
4. Electrical contractor is responsible for wiring from starter to motor, unless factory wired.
5. Temperature control contractor shall provide conduit and wire from auxiliary contact in motor starter to the detector so that the unit shuts down in all operating modes. Fire Alarm Contractor to wire from detector to fire alarm panel.
6. Each division shall be fully responsible for any control panels as called for on the drawings or specifications.
 - a. Division 26 shall provide all power and control wiring to fire/smoke or smoke dampers. Division 23 and 26/28 shall provide parallel control wiring (with 28 fire alarm having priority signal) to dampers and equipment utilized in both normal and smoke control modes. Refer to Smoke Control and Fire Alarm Drawings and the Fire Alarm Matrix.
 - b. Fire alarm system shall override automated building control system during smoke exhaust mode.
 - c. TC wiring to fire/smoke or smoke dampers required only when damper also serves HVAC system.
7. Mechanical contractor shall be responsible for fully functional heat trace system. Mechanical contractor shall engage licensed electrician to install heat trace system. Where applicable, mechanical contractor shall engage temperature controls contractor to install control wiring to Division 23 09 00 system.
8. Electrical contractor shall bring power to a fused disconnect adjacent to the motor control center. This disconnect shall be the line of delineation for the Ice Plant Contractor and the Electrical Contractor. The electrical contractor shall make the terminations to this disconnect on the line side of this equipment. The ice plant contractor shall make the terminations on the load side of the equipment and finish the electrical installation of the motor control center from this termination.

- B. Power Wiring by Divisions 21 through 23: The electrical power for certain equipment provided under Divisions 21 through 23 has not been specifically indicated on the electrical drawings and must be provided by and field coordinated by the Divisions 21 through 23 trade requiring such power.

Sufficient power for this purpose shall be furnished as "spare" dedicated circuit capacity in Division 26's panelboards. All wiring, conduit and electrical devices downstream of the panelboards are the responsibility of the Divisions 21 through 23 trade requiring the power.

1. Such equipment is hereby defined as:
 - a. Electrical heat trace. Required heat trace locations, capacities and specification are shown on the plumbing and mechanical drawings (Division 22 and 23 work).

- b. Fire protection air compressors, dry-pipe control panels and valves. Required connections are included in the Division 21 work and will be shown by that contractor's engineered system design drawings.
 - 1) Pre-action system initiation signals (such as smoke detectors or general alarm conditions in a pre-action zone) shall be provided under Division 28 fire alarm work.
 - 2) Division 21 shall provide pre-action control panel and interconnection between nearest suitable fire alarm panel and location of pre-action valve(s).
 - 3) Division 28 shall provide interconnection between fire command center alarm panel (provided under Division 28) and remote communication fire alarm panel (provided under Division 28).
- c. Infrared plumbing fixtures. Fixtures requiring power are shown on the plumbing drawings and schedules. Provide junction box and or receptacle as required by manufacturer.
- d. Temperature control panels, control air compressors and line voltage power for 24v control transformers. Required connections are included in Division 23 09 00 and will be shown by that contractor's control submittal drawings.
- e. Condensate pumps. Provide power from associated unit or from nearby panelboard.

1.5 GENERAL REQUIREMENTS

A. Connections:

- 1. Connections to all controls directly attached to ducts, piping and mechanical equipment shall be made with flexible connections.

B. Starters:

- 1. Provide magnetic starters for all three phase motors and equipment complete with:
 - a. Control transformers.
 - b. 120V holding coils.
 - c. Integral hand-off-auto switch.
 - d. Auxiliary contacts required for system operation plus one (1) spare.
 - e. Refer to Section 23 05 13 Motors, Starters and Drives.

C. Remote Switches and Pushbutton Stations:

- 1. Provide remote switches and/or pushbutton stations required for manually operated equipment (if no automatic controls have been provided) complete with pilot lights of an approved type lighted by current from load side of starter.

D. Special Requirements:

1. Motors, starters and other electrical equipment installed in moist areas or areas of special conditions, such as explosion proof, shall be designed and approved for installation in such areas with appropriate enclosure.

E. Identification:

1. Provide identification of purpose for each switch and/or pushbutton station furnished. Identification may be either engraved plastic sign permanently mounted to wall below switch or stamping on switch cover proper. All such identification signs and/or switch covers in finished areas shall match other hardware in the immediate area.

F. Control Voltage:

1. Maximum allowable control voltage 120V. Fully protect control circuit conductors in accordance with National Electrical Code.

G. DDC Control Interface:

1. Fully coordinate the requirements of each division with regard to supplying a complete DDC Control System prior to submitting bid.
2. All control power shall be furnished via dedicated line voltage circuits.
3. Dedicated control circuits from electrical panelboards to DDC control panels and from electrical panelboards to dedicated DDC J-boxes (for distributed control components such as VAV boxes), and control transformer line voltage connections shall be provided under Division 23 09 00 where required and as shown on the drawings.
 - a. Exceptions: The following Divisions 21 through 23 equipment has been provided with electrical power feeders downstream of the panelboards by Division 26:
 - 1) Division 28, Fire Alarm System Panels.
 - 2) Division 23 09 00 Building Automation System (BAS):
 - a) Each air handling unit (AHU) has been provided with a dedicated combination control and unit lighting circuit(s) to its air handling room.
 - b) Certain BAS panels requiring emergency power.
 - 3) See the drawings for additional exceptions.
4. Low-voltage wiring from J-boxes to distributed control components, all low-voltage connections, all control panels and all control transformers (not part of unitary equipment) shall be provided under Division 23 09 00.
5. Any additional power requirements shall be the responsibility of the Division 23 09 00 Contractor requiring same and provided at no additional cost to the owner.

1.6 CEILING AND CHASE CAVITY PRECEDENCE

- A. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order of precedence. A system with higher precedence may direct that systems of lower precedence be relocated from space, which is required for expedient routing of the precedent system.
 - 1. Plumbing waste, cooling coil drain piping, and roof drain mains and leaders.
 - 2. Hydronic main piping (12" and larger).
 - 3. Plumbing vent piping.
 - 4. Supply, return and exhaust ductwork.
 - 5. Electrical conduit greater than 4" diameter.
 - 6. Hydronic branch and mains (greater than 2", but less than 12").
 - 7. Domestic water piping.
 - 8. Fire sprinkler mains and leaders.
 - 9. Hydronic branch piping (2" and less).
 - 10. Domestic hot and cold-water branches.
 - 11. Electrical conduit branch feeders.
 - 12. Fire sprinkler branch piping and sprinkler runouts.
- B. Light fixtures have precedence in a zone, which is the same height above the ceiling as the depth of the fixture (plus 2").
- C. Examine the contract documents of all trades (e.g., all Divisions 21 through 23 and 26 through 28 drawings, the architectural floor plans, reflected ceiling plans, elevations and sections, structural plans and sections, etc.).
- D. Coordinate necessary equipment, ductwork and piping locations so that the final installation is compatible with the materials and equipment of the other trades.
- E. Prepare shop drawings for installation of all new work before installation to verify coordination of work between trades.
- F. Provide access doors for all equipment, valves, clean-outs, actuators and controls which require access for adjustment or servicing and which are located in otherwise inaccessible locations.
 - 1. For equipment located in "accessible locations" such as lay-in ceilings: Locate equipment to provide adequate service clearance for normal maintenance without removing architectural, mechanical, electrical or structural elements such as the ceiling support system, electrical fixtures, etc. "Normal maintenance" includes, but is not limited to: filter changing; greasing of bearings; using p/t ports for pressure or temperature measurements; and replacement of ballasts, fuses, etc.

PART 2 - PRODUCTS

2.1 MOTOR HORSEPOWER

- A. In general, all motors $\frac{3}{4}$ HP and above shall be three phase, all motors $\frac{1}{2}$ HP or less shall be single phase.
- B. Voltage and phase of motors as scheduled on the electrical drawings shall take precedence in the case of a conflict between the mechanical and electrical drawings or general condition 2.1. A., above.
- C. Work under Divisions 21 through 23 includes coordinating the electrical requirements of all mechanical equipment with the requirements of the work under Divisions 26 through 28, before ordering the equipment.
 - 1. If motor horsepower are changed under the work of Divisions 21 through 23 without a change in duty of the motor's driven device, coordination of additional electrical work (if any) and additional payment for that work (if any) shall be provided under the section of Divisions 21 through 23 initiating the change. Increases or decreases in motor horsepower from that specified shall not be made without written approval from the Architect/Engineer.

PART 3 - EXECUTION - (NOT USED)

END OF SECTION 23 05 01/26 05 01

SECTION 23 05 02 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. This Section supplements Division 1 - General Requirements.
- B. Where contradictions occur between this Section and Division 1, the more stringent of the two shall apply. Architect/Engineer shall decide which is more stringent.
- C. Provisions of this section shall also apply to all sections of Divisions 21 through 23.

1.2 DEFINITIONS

- A. The definitions of Division 1 and the General Conditions of this specification also apply to Divisions 21 through 23 contract.
- B. "Contract Documents" constitute the drawings, specifications, general conditions, project manuals, etc., prepared by Engineer (or other design professional in association with Engineer) for contractor's bid or contractor's negotiations with the Owner. Divisions 21 through 23 drawings and specifications prepared by the Engineer are not construction documents.
- C. "Construction Documents", "construction drawings", and similar terms for Divisions 21 through 23 work refer to installation diagrams, shop drawings and coordination drawings prepared by the contractor using the design intent indicated on the Engineer's contract documents. These specifications detail the contractor's responsibility for "Engineering by Contractor" and for preparation of construction documents.
- D. "(N)" indicates "new" equipment to be provided under this contract.
- E. "(E)" indicates "existing" equipment on site which may or may not need to be relocated as a part of this work.
- F. "(R)" indicates existing equipment to be relocated as part of this work.
- G. "Furnish" means to "supply" and usually refers to an item of equipment.
- H. "Install" means to "set in place, connect and place in full operational order".
- I. "Provide" means to "furnish and install".
- J. "Equal" or "Equivalent" means "meets the specifications of the reference product or item in all significant aspects." Significant aspects shall be as determined by the Architect/Engineer.

- K. "Work by other(s) divisions"; "re: _____ Division", and similar expressions means work to be performed under the contract documents, but not necessarily under the division or section of the work on which the note appears. It is the contractor's sole responsibility to coordinate the work of the contract between his/her suppliers, subcontractors and employees. If clarification is required, consult Architect/Engineer before submitting bid. By inference, any reference to a "contractor" or "sub-contractor" means the entity, which has contracted with the Owner for the work of the Contract Documents.
- L. By inference, any reference to a "contractor" or "sub-contractor" means the entity, which has contracted with the owner for the work of the Contract Documents.
- M. "Engineer" means the design professional firm, which has prepared these contract documents. All questions, submittals, etc. of this division shall be routed to the Engineer (through proper contractual channels).

1.3 COORDINATION WITHIN DIVISIONS 21 THROUGH 23

- A. Contract Documents:
 - 1. General: The Contract Documents are diagrammatic showing certain physical relationships, which must be established within the Divisions 21 through 23 work and its interface with other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing material quantities.
 - 2. Supplemental Instructions: The exact location for some items in this Specification may not be shown on the Drawings. The location of such items may be established by the Architect/Engineer during the progress of the work.
 - 3. Discrepancies:
 - a. Examine Drawings and Specifications of all Divisions of the work.
 - b. Report any discrepancies to the Architect/Engineer and obtain written instructions before proceeding.
 - c. Should there be a conflict within or between the Specifications or Drawings, the more stringent or higher quality requirements shall apply.
 - d. Items called for in either specifications or drawings shall be required as if called for in both.
 - 4. Constructability:
 - a. Examine Drawings and Specifications of all Divisions of the work.
 - b. Report any issues to the Architect/Engineer which may prevent installation of Divisions 21 through 23 work in accordance with the Contract Documents and the original construction contract.
 - c. Report all issues within 30 days after contract.

- B. Be responsible for providing proper documentation of equipment product data and shop drawings to all entities providing service. This coordination shall include, but not be limited to the following:
1. Division 21 - Series contractor (Fire Protection Contractor) shall provide shop drawings to all other Division 21 through 23 contractors.
 2. Division 23 09 00 and 23 05 93 - Contractors (Automatic Temperature Controls, Building Management and Test-Adjust-Balance Contractors) shall be provided with equipment product data and shop drawings as appropriate from other Division 21 through 23 and Divisions 26 through 28 contractors, and shall furnish the same information about control devices (such as valves, test wells, etc.) to the appropriate Divisions 21 through 23 Contractor.
- C. Coordination Drawings:
1. Submit coordination drawings for all Divisions 21 through 23 work. The drawings shall be fully coordinated and signed off by all affected trades prior to submission. The coordination drawings shall include the following at a minimum.
 - a. All major ductwork, piping, conduit and equipment.
 - b. Reflected ceiling plans with light fixtures.
 - c. Current architectural floor plans.
 - d. Major structural elements.
 - e. Elevations of piping ductwork or equipment.
 - f. Sections through critical spaces.
 2. The drawings shall be at a suitable scale (1/8"=1'-0" minimum) to clearly show information.
 3. Any work installed without approved coordination drawings is done at the Contractor's risk.
- D. Electronic Drawings:
1. Electronic drawings are available from ME Engineers. One complete set of electronic drawings in Revit or CAD format to be provided to GC for distribution. Electronic drawings are for reference only and available only upon receipt of electronic document disclaimer.
- E. Existing Conditions:
1. Inspect existing conditions prior to bidding.
 2. Provide proper coordination of mechanical work with existing conditions.
- F. Utility Connections:
1. Coordinate the connection of mechanical system with the Civil drawings and utility companies.

2. Comply with regulations of utility suppliers.
3. The Contract Documents indicate the available information on existing utilities and services, and on new services (if any) to be provided to the project by utility companies and agencies.
 - a. Notify Architect/Engineer immediately if discrepancies are found.
4. Coordinate mechanical utility interruptions one week in advance with the Owner and the Utility Company.
 - a. Plan work so that duration of the interruption is kept to a minimum.

1.4 COORDINATION WITH OTHER DIVISIONS

A. General:

1. Coordinate Divisions 21 through 23 work to the progress of the work of other trades.
2. Complete the entire installation as soon as the condition of the building will permit.
3. The project will be constructed under multiple bid packages. Coordinate this Division's work with the progress of the other bid package's work.

B. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order:

1. Plumbing waste, cooling coil drain piping, and roof drain mains and leaders.
2. Hydronic main piping (12" and larger).
3. Plumbing vent piping.
4. Supply, return and exhaust ductwork.
5. Electrical conduit greater than 4" diameter.
6. Hydronic branch and mains (greater than 2", but less than 12").
7. Domestic water piping.
8. Fire sprinkler mains and leaders.
9. Hydronic branch piping (2" and less).
10. Domestic hot and cold-water branches.
11. Electrical conduit branch feeders.
12. Fire sprinkler branch piping and sprinkler runouts.

C. Coordination with Electrical Work. Refer to Section 23 05 01.

D. Cutting and Patching: Refer to Division 1 and Section 23 05 03.

E. Chases, Inserts and Openings:

1. Provide measurements, drawings, and layouts so that openings, inserts and chases in new construction can be built in as construction progresses.

2. Check sizes and locations of openings provided.
 - a. Any cutting and patching made necessary by failure to provide measurements, drawings, and layouts at the proper time shall be done at no additional cost to the Owner.
 - b. Coordinate roof openings for all roof-mounted equipment. Openings on documents are diagrammatic and do not represent manufacturer specific requirements. Actual opening size, orientation and location, as well as structural coordination, is the responsibility of the mechanical contractor.
 - c. Provide transitions on ductwork to accommodate actual roof openings.
- F. Support Dimensions: Provide dimensions and drawings so that concrete bases and other equipment supports to be provided under other Sections of the Specifications can be built at the proper time.

1.5 COORDINATION WITH EXISTING OCCUPIED AREAS

- A. Minimize disruptions to operation of mechanical systems in occupied areas.
- B. Coordinate any required disruptions with the Owner, one week in advance.
- C. Provide temporary connections to prevent long disruptions.

1.6 ENGINEERING BY CONTRACTOR

- A. The construction of this building requires the contractor to design several systems or subsystems. All such designs shall be the complete responsibility of the contractor.
- B. Systems or subsystems which require engineering responsibility by the contractor include, but are not limited to:
 1. Any system not fully detailed on the drawings.
 2. Fire sprinkler.
 3. Equipment supports, and hangers not fully detailed in the drawings.
 4. Pipe hangers, sleeves and anchors not specified in these documents, or cataloged by the manufacturer.
 5. Fire stopping
 6. Duct supports, hangers and miscellaneous steel as required.
 7. Temperature controls.
 8. Refrigeration systems.
 9. Piping expansion and contraction provisions.
 10. Equipment supports, hangers.
 11. Sizing and routing of condensate piping.

1.7 REGULATORY REQUIREMENTS

- A. Codes: Comply with the following:
 - 1. International Building Code 2018
 - 2. International Mechanical Code 2018
 - 3. International Plumbing Code 2018
 - 4. National Electric Code (NEC) Latest Edition
 - 5. International Fire Code 2018
 - 6. ASME Boiler and Pressure Vessel Code.
 - 7. Local Modifications to above Codes.
- B. Applicable pamphlets of NFPA.
- C. Requirements of Local Utility Companies:
 - 1. Comply with rules and regulations of local utility companies. Include in bid the cost of all valves, valve boxes, meter boxes, meters and such accessory equipment which will be required for the project.
- D. Other Regulations: Comply with the latest editions of the following:
 - 1. U.S. and State Department of Labor Safety Regulations pertaining to the completed project.
 - 2. Requirements of Fire Departments serving the project.
 - 3. Regulations of the Health Department having jurisdiction.
 - 4. Regulations of the Office of State Fire Marshal.
 - 5. ASHRAE Energy Conservation Standard 90.1.
 - 6. ASHRAE Ventilation Standard 62.
 - 7. Requirements of the State Oil Inspector.
 - 8. Americans with Disabilities Act (ADA).
 - 9. Clean Air Act.
 - 10. Colorado Air Quality Control Commission Regulation #15.
 - 11. Clean Water Act.
 - 12. USGBC LEED-NC v4.0.
 - a. In particular, all sealants and adhesives shall be low VOC type as defined by USGBC LEED-NC v4.0.
- E. Additional Regulations: Follow additional regulations, which appear in individual Sections of these Specifications.
- F. Contradictions: Where codes are contradictory, follow the most stringent, unless otherwise indicated in Plans or Specifications. Architect/Engineer shall determine which is most stringent.

G. Contract Documents Not in Compliance:

1. Where the Drawings and Specifications do not comply with the minimum requirements of the Codes, either notify the Architect/Engineer, in writing during the Bidding Period, of the revisions required to meet Code requirements, or provide an installation which complies with the Code requirements. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.
2. Follow Drawings and Specifications where they are superior to Code requirements.

H. Permits:

1. Obtain all permits required by authorities and agencies having jurisdiction for the work of this Division.
2. Post permits as required.

I. Tap and Connection Fees:

1. Pay fees charged by Utilities for making connections, bringing service to property line, or to meter and similar services.
2. Investment fees or plant development fees, which are charges levied by Utilities to cover the cost of the utility system to be borne by this project, are not part of the work of this Division.

J. Inspections and Tests:

1. Arrange for all required inspections and tests.
2. Pay all charges.
3. Notify Architect/Engineer 48 hours before tests.
4. Submit one copy for Owners records of permits, licenses, inspection reports and test reports.

K. LEED

1. This project will follow the guidelines and requirements of Leadership in Energy and Environmental Design (LEED). Provide all services and documentation required in this effort.
2. Commissioning: The project will have selected building systems commissioned as specified in Section 01810 – Commissioning. Coordinate pre-functional tests and start-up testing with commissioning.

1.8 RECORD DRAWINGS

A. General Recording Procedure:

1. Maintain a blue-line set of Divisions 21 through 23 Contract Drawings in clean, undamaged condition, for mark-up of installations, which vary, substantially from the Contract Drawings.
2. Record changes drawn to scale and fully dimensioned, as specified in Division 1.
 - a. Work concealed behind or within other work, in an inaccessible arrangement.
 - b. Mains and branches of piping systems:
 - 1) with valves and control devices located and numbered.
 - 2) with concealed unions located.
 - 3) with items requiring maintenance located (traps, strainers, expansion compensators, tanks, etc.).
 - c. Underground piping and ducts, both exterior and interior.
 - d. Ductwork layouts, including locations of coils, dampers, filters, boxes and similar units.
 - e. Concealed control system devices and sensors.

B. Corrected Drawings:

1. Obtain a set of contract drawings on CAD.
2. Update the CAD files to reflect as-built conditions.
3. Transmit corrected CAD files and plots as a submittal to the Architect/Engineer for Owner's use and record.

C. Temperature Control Drawings:

1. Indicate as-built conditions of work under this contract including:
 - a. Ladder wiring diagram.
 - b. Pneumatic schematic diagrams.
 - c. One line system diagram.
 - d. Control schematic of equipment with control devices located and identified.
 - e. Wiring or tubing termination diagrams.
 - f. List of materials.
 - g. Floor plan indicating all device locations.
 - h. Control sequences.
 - i. Indicate electrical power source for each point of connection to the electrical system.
2. Reproducible temperature control drawings shall be delivered to the Architect/Engineer prior to Owner's acceptance of project.

1.9 OPERATING AND MAINTENANCE DATA

- A. Refer to Division 1 for additional requirements.
- B. Submission:
 - 1. Submit typed and bound copies of Operating and Maintenance Manuals prior to scheduling systems demonstration for the Owner, as specified in Division 1.
 - 2. Bind each Maintenance Manual in one or more vinyl covered, 3-ring binders, with pockets for folded drawings.
 - a. Mark the back spine of each binder with system identification and volume number.
- C. Required Contents:
 - 1. Manuals shall have index with tab dividers for each major equipment section to facilitate locating information on specific piece of equipment.
 - 2. Identify data within each section with drawing code numbers as they appear on Drawings and Specifications. Include as a minimum the following data:
 - a. Alphabetical list of system components, with the name, address and 24 hour telephone number of the company responsible for servicing each item during the first year of operation. Include point of contact for company.
 - b. Operating instructions for complete system including:
 - 1) Emergency procedures for fire and failure of major equipment.
 - 2) Major start, operation and shut-down procedures.
 - c. Maintenance Instructions for each piece of equipment including:
 - 1) Equipment lists.
 - 2) Proper lubricants and lubricating instructions for each piece of equipment.
 - 3) Necessary cleaning, replacement and/or adjustment schedule.
 - 4) Product Data.
 - 5) Installation instructions.
 - 6) Parts lists.
 - 7) Complete wiring diagrams.
 - d. Temperature control diagrams and O&M information as specified above (as-built).
 - e. Marked or changed prints locating concealed parts and variations from the original system design (as-built drawings).
 - f. Balancing Report.
 - g. Valve schedule and associated piping schematics. See Division 23 05 53, Mechanical Identification.
 - h. Copies of any extended equipment warranties, which are greater than one year.

1.10 WARRANTIES

- A. The warranty period is one year after Date of Acceptance.
 - 1. During this period, provide labor and materials as required to repair or replace defects in the mechanical system at no additional cost to the Owner. Provide certificate with O&M manual submittal which guarantees same-day service response to Owners call for all such warranty service.
 - 2. Provide certificates for such items of equipment which have warranties in excess of one year. Insert copies in O&M manuals. Such equipment shall include:
 - a. Temperature Control Valves five (5) years.
 - b. Chiller compressors five (5) years.
 - 3. Provide extended manufacturers warranties to cover one full year from date of acceptance if standard warranty starts any time prior to that date.
 - 4. Provide factory trained service personnel for all warranty work on the DDC Control System and the following equipment:
 - a. Air cooled chiller.
 - b. Boilers.
- B. Refer to Division 1 for additional requirements.

1.11 SCOPE

- A. The Contractor shall:
 - 1. Supply all labor, transportation, materials, apparatus, light, and tools necessary for the completion of the mechanical work.
 - 2. Install, maintain, and remove all construction equipment.
 - 3. Be responsible for safe, lawful, and proper construction maintenance.
 - 4. Construct, in the best and most workmanlike manner, a complete project and everything properly incidental thereto, as shown on the Drawings, as stated in the Specifications, or reasonably implied therefrom, all in accordance with the Contract documents.

1.12 MANDATORY GOVERNING PROVISION

- A. Omissions of words or phrases, such as “the Contractor shall,” “in conformity with,” “shall be,” “as noted on the Drawings,” “according to the Drawings,” “an,” “the,” and “all,” are intentional.
- B. Omitted words or phrases shall be supplied by inference.

1.13 PROTECTION OF PROPERTY AND MATERIALS

- A. Provide protection against dust migration, rain, wind, storms, frost, or heat, so as to maintain all work, materials, apparatus, and fixtures free from injury or damage.
- B. At end of each day's work, cover all new work likely to be damaged.
- C. Do not interrupt the integrity of the building security overnight.
- D. Refer to Division 1 for additional requirements.

1.14 OWNER FURNISHED EQUIPMENT

- A. All equipment called out in the Specifications or shown on the Drawings as "Owner-Furnished Equipment" shall be installed and connected under this Contract. Provide rough-ins for all future connections indicated.

1.15 TEMPORARY FACILITIES

- A. Light, Heat, Power, etc.
 - 1. Responsibility for providing temporary electricity, heat and other facilities shall be as specified in Division 1.
 - 2. Contractor shall be responsible for maintaining the equipment in an as-new condition. Equipment will not be turned over to the Owner until it is brought up to as-new condition.
 - 3. The contractor shall be responsible for maintaining acceptable indoor air quality in adjacent occupied spaces.
- B. Use of Permanent Building Equipment for Temporary Heating or Cooling.
 - 1. Permanent building equipment shall not be used without written permission from the Owner. If this equipment is used for temporary heating or cooling, it shall be adequately maintained per manufacturer's instructions and protected with filters, strainers, controls, reliefs, etc. The contractor shall protect all equipment and systems as directed by the engineer. The warranty period shall not start until the equipment is turned over to the Owner for his use. The contractor shall provide extended warranties for parts and labor for all such equipment. Equipment shall not be turned over to the Owner until the temperature controls have been tested and accepted by the Owner and Engineer.

1.16 ROUGH-IN FOR FUTURE CONNECTION

- A. Provide rough-in services for all systems which shall extend to future equipment or spaces as shown on the drawings.
 - 1. Provide sufficiently sized branch plumbing lines with isolation valves to serve Building B and Plaza F&B Building with heating hot water and chilled water.
 - 2. BAS/ATC Controls:
 - a. Provide sufficiently sized master control panel(s) to accommodate a 10% increase in the number of equipment unit controllers in the Promenade building area plus any future equipment unit controllers in the Plaza Building and Building B.
 - b. Provide sufficient electrical conduits (and J-boxes) from the master control panel(s) to a future point of connection with Building B and Plaza F&B buildings. The conduits shall be sized to accommodate the same number of wire and cables to each future Building B and Plaza F&B area as is necessary to accommodate similar areas.

1.17 INSTALLATION GENERAL REQUIREMENTS

- A. Furnish, apply, install, connect, erect, clean, and condition manufactured materials and equipment as recommended in manufacturer's printed directions (maintained on job site during installation).
- B. Provide all attachment devices and materials necessary to secure materials together or to other materials.
- C. Make allowance for ample and normal expansion and contraction for all building components and piping systems that are subject to such.
- D. Install materials only when conditions of temperature, moisture, humidity, and conditions of adjacent building components are conducive to achieving the best installation results.
- E. Erect, install, and secure components in a structurally sound and appropriate manner.
- F. Where necessary, temporarily brace, shore, or otherwise support members until final connections are installed.
- G. Leave all temporary bracing, shoring, or other structural supports in place as long as practical for safety and to maintain proper alignment.
- H. Handle materials in a manner to prevent scratching, abrading, distortion, chipping, breaking, or other disfigurement.
- I. Conduct work in a manner to avoid injury or damage to previously placed work.

- J. Any work so impaired or damaged shall be replaced at no expense to Owner.
- K. Fabricate and install materials true to line, plumb, and level.
- L. Leave finished surfaces smooth and flat, free from wrinkles, warps, scratches, dents, and other imperfections.
- M. Furnish materials in longest practical lengths and largest practical sizes to avoid all unnecessary jointing.
- N. Make all joints secure, tightly fitted, and as inconspicuous as possible by the best accepted practice in joinery and fabrication.
- O. Consult Engineer for mounting height or position of any unit not specifically indicated or located on Drawings or specified in Specifications.
- P. Job mixed multi-component materials used in the work shall be mixed in such regulated and properly sized batches that material can be used before it begins to “set”.
- Q. Mixing of a partially “set” batch with another batch of fresh materials will not be accepted and entire batch shall be discarded and removed from site.
- R. Clean all mixing tools and appliances that can be contaminated prior to mixing of fresh materials.
- S. In addition to the above refer to each Section of the Specifications for additional installation requirements for the proper completion of all work.

PART 2 - PRODUCTS

2.1 QUALITY CONTROL

- A. Refer to Division 1 of the Specifications.
- B. The manufacturer of equipment or materials listed on the drawings or specifically indicated in the specification is the basis of design. If the drawings and specifications are in conflict, the drawings shall take precedence. Other manufacturers listed are considered general equivalents only. See below for coordination of substitutions.
- C. Products by manufacturers not listed in this Specification may be submitted to the Engineer only during normal submittal procedure, and only as “substitutions”. All bids must use basis of design or listed general equivalents.

- D. Items submitted as a substitution to the basis of design or listed general equivalents shall be identified as such and shall include a written request for substitution indicating the following:
1. Contract price adjustment.
 2. Contract time adjustment.
 3. Item by item breakdown of differences between basis of design and substituted item.
 4. Operation, maintenance, and energy cost difference.
- E. Coordination of general equivalents and substitutions: Where Contract Documents permit selection from several general equivalents, or where substitutions are authorized, coordinate clearance and other interface requirements with mechanical and other work.
1. Provide necessary additional items so that selected or substituted item operates equivalent to the basis of design and properly fits in the available space allocated for the basis of design.
 2. Provide all features which are standard on the basis of design.
 3. Contractor is responsible for assuring that piping, conduit, duct, flue, and other service locations for general equivalents or substitutions do not cause access, service, or operational difficulties any greater than would be encountered with the basis of design.

2.2 GENERAL SUBMITTAL REQUIREMENTS

- A. Refer to Division 1.
- B. Coordination and Sequencing:
1. Coordinate submittals 2 weeks (min.) prior to expected order date so that work will not be delayed by submittals.
 2. No extension of time will be allowed because of failure to properly coordinate and sequence submittals.
 3. Do not submit product data, or allow its use on the project until compliance with requirement of Contract Documents has been confirmed by Contractor.
 4. Submittal is for information and record, unless otherwise indicated, and is not a change order request.
 5. Submitting contractor is responsible for routing reviewed submittals to all parties affected including but not limited to electrical, temperature control, and test and balance subcontractors.
- C. Preparation of Submittals:
1. Refer to Division 1 requirements.
 2. Provide permanent marking on each submittal to identify project, date, Contractor, Subcontractor, Supplier, submittal name and similar information to distinguish it from other submittals.

3. Indicate any portions of work which deviate from the Contract Documents.
 - a. Explain the reasons for the deviations.
 - b. Show how such deviations coordinate with interfacing portions of other work.
 4. Show Contractor's executed review and approval marking.
 5. Provide space for Architect's/Engineer's "Action" marking.
 6. Submittals which are received from sources other than through Contractor's office will be returned "Without Action".
 7. Submittals shall be presented in a neat and legible fashion and shall be returned "Without Action" if presented in any other fashion.
 8. Submittals shall have index with tab dividers for each component to facilitate locating information on specific pieces of equipment and products.
- D. Quantities: Unless otherwise indicated in Division 1, submit six copies.
1. Refer to Division 1 requirements.
 2. Multiple System Items: Where a required submittal relates to an operation or item of equipment used in more than one system, increase the number of final copies as necessary to complete the Maintenance Manuals for each system.
 3. Preliminary Submittal: Provide a preliminary, two-copy submittal for automatic temperature controls and when product data is required (or desired by Contractor) for selection of options by Architect/Engineer.
 4. General Distribution:
 - a. Provide additional distribution of submittals (not included in foregoing copy submittal requirements) to Subcontractors, Suppliers, Fabricators, Installers, Governing Authorities and others as necessary for proper performance of the work.
 - b. Include such additional copies in transmittal to Architect/Engineer where required to receive "Action" marking before final distribution.
 - 1) Show such distributions on transmittal forms.
- E. LEED Submittals:
1. Credit WE 3.1 and 3.2: Product Data for plumbing fixtures indicating water consumption. Prerequisite EA 3.0: Product Data for new HVAC equipment indicating absence of CFC refrigerants.
 2. Credit EA 4.0: Product Data for new HVAC equipment indicating absence of HCFC refrigerants.
 3. Credit EA 5.0: Product Data and wiring diagrams for sensors and data collection system used to provide continuous metering of building energy and water consumption performance over time.
 4. Credit EQ 1.0: Product Data and Shop Drawings for carbon dioxide monitoring system and/or outdoor air monitoring station.

5. Credit EQ 3.1:
 - a. Construction Indoor Air Quality (IAQ) management plan.
 - b. Product Data for temporary MERV 8 filtration media.
 - c. Construction Documentation: Six photographs at three different occasions during construction of the different SMACNA requirements along with a brief description of the SMACNA approach employed, documenting implementation of the IAQ management measures, such as protection of ducts, cleaning of air handling units, installation of filters, and on-site stored or installed absorptive materials.
 6. Credit EQ 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 MERV 8 filtration media used during flush-out.
 - c. Report from testing and inspecting agency indicating results of IAQ testing and documentation showing conformance with IAQ testing procedures and requirements.
 7. Credit EQ 4.1: Product Data for adhesives and sealants used on the interior of the building indicating VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D (EPA method 24).
 8. Credit EQ 4.2: Product Data for paints and coatings used on the interior of the building indicating chemical composition and VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D (EPA method 24).
 9. Credit EQ 5: Product Data for MERV 13 filtration media used during occupancy.
 10. Credit EQ 7.1: Product Data and Shop Drawings for sensors and control system used to monitor and control room temperature.
- F. Response to Submittals: Where standard product data have been submitted, it is recognized:
1. That the Submitter has determined that the products fulfill the specified requirements.
 2. That the submittal is for the Architect's or Engineer's information only, but will be returned with appropriate action where observed to be not in compliance with the requirements.
- G. If more than two submissions (either for shop drawings, as-built drawings, or test and balance reports) are made by the contractor, the Owner reserves the right to charge the contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the contractor.

2.3 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS

A. Manufacturer's Data:

1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which of the variations is to be provided.
2. Delete or mark-out significant portions of pre-printed data which are not applicable.
3. Where operating ranges are shown, mark data to show portion of range required for project application.
4. For each product, include the following:
 - a. Sizes
 - b. Weights
 - c. Speeds
 - d. Capacities
 - e. Piping and electrical connection sizes and locations.
 - f. Statements of compliance with the required standards and regulations.
 - g. Performance data.
 - h. Manufacturer's specifications and installation instructions.

B. Shop Drawings:

1. Prepare Mechanical Shop Drawings, except diagrams, to accurate scale.
 - a. Show clearance dimensions at critical locations.
 - b. Show dimensions of spaces required for operation and maintenance.
 - c. Show interfaces with other work, including structural support.

C. Test Reports:

1. Submit test reports which have been signed and dated by the firm performing the test.
2. Prepare test reports in the manner specified in the standard or regulation governing the test procedure (if any) as indicated.

D. Required equipment and shop drawing submittals:

1. Provide a submittal schedule with bid.
2. Provide equipment submittals for each item of equipment specified or scheduled in the contract documents.
3. Submittal Schedule shall show each item of equipment, applicable Section of the specifications where it is described, applicable Drawing number and schedule name where it is scheduled, date of Contractor's proposed submittal to Architect, required date to receive submittal from Architect and schedule order date.
4. Provide a Mechanical Shop Drawing Schedule for submission to the Architect with the Submittal Schedule. Refer to paragraph 1.3 -Coordination Within Divisions 21 through 23 above.

5. Review of shop drawings and product data by the Architect/Engineer, including any review annotations or stamp notations, does not relieve the contractor from the required compliance with the contract documents.
6. The shop drawing and product data review stamp notation requirements are defined as follows:
 - a. “NO EXCEPTION TAKEN:” The reviewer did not observe any items which were not in compliance with the contract documents. All dimensions, details, and coordination with other trades are the responsibility of the contractor.
 - b. “MAKE CORRECTIONS NOTED:” The reviewer indicated items observed that were not in compliance with the contract documents. The contractor shall not resubmit, but shall make corrections and provide corrected documents with the “Record Drawings.”
 - c. “REJECTED, REVISE AND RESUBMIT:” The reviewer indicated items observed which were not in compliance with the contract documents. The contractor shall resubmit showing corrections of all noted items. Delays for resubmittal do not relieve the contractor from meeting project schedules.
 - d. “REJECTED:” The submission does not comply with the contract requirements. The entire submittal must be corrected and submitted for review. Delays for resubmittal do not relieve the contractor from meeting project schedules.
7. If shop drawings are submitted and returned as “NO EXCEPTION TAKEN” or “MAKE CORRECTIONS NOTED” and meet contract requirements, the contractor shall not resubmit any other shop drawings for these items.
8. If resubmittals are necessary, they shall be made as specified above for submittals. Resubmittals shall highlight all revisions made and cover shall include the phrase “RESUBMITTAL NO. _____.”
Resubmittal requirements do not entitle the Contractor to additional time and are not a cause for delay of the project.

2.4 COMPATIBILITY

- A. General: Provide products which are compatible with other products of the mechanical work and with other work requiring interface with the mechanical work.
- B. Altitude Ratings: Except where noted otherwise, all ratings and capacities stated in the Contract Documents are at the altitude of the project, not sea level. Project Altitude shall be considered to be 6,700 feet.
- C. Fuel Characteristics:
 1. Review fuel characteristics with the Fuel Supplier designated by the Owner.
 2. Determine burner or combustion equipment provisions needed for optimum performance. Provide equipment accordingly.

D. Power Characteristics:

1. For power characteristics of equipment supplied under Division 21 through 23 Sections, refer to the Sections of Divisions 26 through 28 and the Electrical Drawings for the power characteristics of each power-driven item of mechanical equipment.
2. Coordinate available power with Electrical Contractor before ordering equipment. Mechanical Contractor shall be responsible for ordering equipment to meet the available power characteristics.
3. See also Division 23 05 01 of these specifications.
4. If there is a conflict between Divisions 21 through 23 documents and Divisions 26 through 28 documents, alert the engineer. Do not order equipment prior to determining the proper electrical service. No contract cost adjustment will be allowed for equipment ordered in conflict with the available power characteristics.

2.5 SAFETY PROVISIONS

A. Equipment Nameplates: Provide power-operated mechanical equipment with a permanent nameplate attached by the manufacturer, indicating:

1. The manufacturer
2. Product name
3. Model number
4. Serial number
5. Speed
6. Capacity
7. Power characteristics
8. Labels of testing, listing, or inspecting agencies
9. Other similar data

B. Where manufacturer affixed nameplate is not available, Mechanical Contractor shall fabricate and attach nameplate.

C. Guards:

1. Unless equivalent guards are provided integral with the equipment, enclose each belt drive (including sheaves) on both side in a galvanized, one-inch, mesh screen of No. 18-gauge steel wire or expanded metal, fastened to an approved, structural steel frame, securely fastened to the equipment or floor.
2. Provide tachometer holes at shaft centers. Unless equivalent guards are provided integral with the equipment, install a solid guard of No. 20-gauge galvanized steel over the coupling of each item of direct-driven equipment.
3. Sides are not required on these guards except to ensure rigidity.

2.6 SAFETY PROVISIONS

- A. Any refrigeration system containing CFC-11, CFC-12, HCFC-123, HCFC-22, or any of the other refrigerants listed in the Clean Air Act as a Class I or Class II Ozone Depleting Compound shall comply with the Clean Air Act and the Colorado Air Quality Control Commission Regulation #15.
- B. As a minimum all systems shall be equipped with refrigerant recovery service valves, relief valves capable of resetting after activation, and for system with more than 50 pounds of charge, and isolateable receiver and/or condenser capable of holding the complete charge.

PART 3 - EXECUTION

3.1 COORDINATION OF MECHANICAL INSTALLATION

- A. Inspection and Preparation:
 - 1. Examine the work interfacing with mechanical work, and the conditions under which the work will be performed, and notify the Architect/Engineer of conditions detrimental to the proper completion of the work at original contract price.
 - 2. Do not proceed with the work until unsatisfactory conditions have been corrected.
- B. Layout:
 - 1. Layout the mechanical work in conformity with the Contract Drawings, Coordination Drawings and other Shop Drawings, product data and similar requirements so that the entire mechanical plant will perform as an integrated system, properly interfaced with other work, recognizing that portions of the work are shown only in diagrammatic form.
 - 2. Where coordination requirements conflict with individual system requirements, comply with the Architect's or Engineer's decision on resolution of the conflict.
 - 3. Take necessary field measurements to determine space and connection requirements.
 - 4. Provide sizes and shapes of equipment so the final installation conforms to the intent of the Contract Documents.
- C. Integrate mechanical work in ceiling spaces with suspension system, light fixtures and other work so that required performances of each will be achieved.

3.2 PRODUCT INSTALLATION

- A. Manufacturer's Instructions:
 - 1. Except where more stringent requirements are indicated, comply with the product manufacturer's instructions and recommendations.

2. Consult with manufacturer's technical representatives, who are recognized as technical experts, for specific instructions on special project conditions.
3. If a conflict exists, notify the Architect/Engineer in writing and obtain his instruction before proceeding with the work in question.

B. Movement of Equipment:

1. Wherever possible, arrange for the movement and positioning of equipment so that enclosing partitions, walls and roofs will not be delayed or need to be removed.
2. Otherwise, advise Contractor of opening requirements to be maintained for the subsequent entry of equipment.

C. Heavy Equipment:

1. Coordinate the movement of heavy items with shoring and bracing so that the building structure will not be overloaded during the movement and installation.
2. Where mechanical products to be installed on the existing roof are too heavy to be hand-carried, do not transport across the existing roof deck; position by crane or other device so as to avoid overloading the roof deck.

D. Return Air Path: Coordinate mechanical work in return air plenum to avoid obstructing return air path.

1. Do not make changes in layout which will reduce return air path cross-sectional areas. Minimum cross-sectional area will provide an average of 500 fpm and a maximum of 750 fpm velocity through return air plenum at specified supply air quantity unless otherwise noted.
2. Provide openings in any full height walls to allow for free movement of return air. Openings are to be sized for 500-750 fpm velocity. Notify the Architect/Engineer for any openings required in fire rated walls that are not shown on the contract drawings.
3. Report any obstructions by work of other Divisions to Architect/Engineer.

E. Clearances:

1. Install piping and ductwork:
 - a. Straight and true.
 - b. Aligned with other work.
 - c. Close to walls and overhead structure (allowing for insulation).
 - d. Concealed, where possible, in occupied spaces.
 - e. Out-of-the-way with maximum passageway and headroom remaining in each space. In spaces without ceilings, mechanical systems are to be installed tight to the underside of structure. Sloping pipe runs must originate tight to structure to allow for maximum installed height throughout.

2. Except as otherwise indicated, arrange mechanical services and overhead equipment with a minimum of:
 - a. 7'0" headroom in storage spaces.
 - b. 8'6" headroom in other spaces; where approved by Architect.
3. Do not obstruct windows, doors or other openings.
4. Give the right-of-way to piping systems required to slope for drainage (over other service lines and ductwork).

F. Access:

1. Provide for removal, without damage to other parts, of:
 - a. Coils
 - b. Humidifier manifolds
 - c. Tubes
 - d. Shafts
 - e. Fan wheels
 - f. Drives
 - g. Filters
 - h. Strainers
 - i. Bearings
 - j. Control components
 - k. Other parts requiring periodic replacement or maintenance
2. Connect equipment for ease of disconnecting with minimum of interference with other work.
3. Provide unions where required.
4. Locate operating and control equipment and devices for each access.
5. Provide access panels where units are concealed by non-accessible finishes and similar work. See Section 23 05 03.
6. Extend all grease fittings to an accessible location.

3.3 PROTECTION OF WORK

- A. All pipe ends, valves, ducts, and equipment left unconnected shall be capped, plugged or otherwise properly protected to prevent damage or the intrusion of foreign matter.
- B. Do not allow any fans in the HVAC system to operate before the area served by the fan has been cleaned and vacuumed of all debris and dust which might enter the system.
- C. Any equipment, duct or piping systems found to have been damaged or contaminated above "MILL" or "SHOP" conditions shall be replaced or cleaned to the Engineer's satisfaction.

D. Initial fill of traps:

1. Provide initial water seal fill for all waste P-traps, condensate traps, or similar traps.

3.4 PROTECTION OF POTABLE WATER SYSTEMS

- A. All temporary water connections shall be made with an approved back flow preventer.
- B. All hose bibs shall have as a minimum, a vacuum breaker, to prevent back flow.
- C. Direct connections to hydronic systems shall only be made through a reduced pressure back flow preventer.

3.5 PROTECTION OF SYSTEMS SERVING OCCUPIED SPACES

- A. Where work is being performed in occupied spaces, or occupancy is to be phased in with ongoing construction, contractor shall prevent contamination of all systems serving the occupants including but not limited to:
 1. Supply or Return Air
 - a. Systems shall be capped or provided with adequate particulate and gas phase filtration to prevent dust, chemical, or biological contamination. Particulate filters shall be as a minimum equivalent to those specified for the completed system.
 2. Domestic Water
 - a. Isolate sterilized portions from non-sterilized portions.

3.6 REFRIGERATION SYSTEMS

- A. All techniques involved in the installation of refrigeration systems shall be certified and trained in accordance with the International Mechanical Code and applicable State Codes, and the applicable sections of the Clean Air Act.
- B. No refrigerant shall be intentionally vented to the atmosphere. All refrigerant shall be recovered before opening a closed system for charging, evacuation, service or installation.
- C. Refrigerants shall meet project LEED requirements.

3.7 ASBESTOS

- A. The identification and/or abatement of asbestos hazards is not part of this contract.
 - 1. If asbestos is encountered, contact Owner for instructions.

3.8 START-UP

- A. Assign a full time Divisions 21 through 23 Start-Up Coordinator to this project.
- B. The Start-Up Coordinator shall develop detailed start-up procedures, equipment checkout procedures and data forms for recording compliance with contract document performance criteria, and will assist in developing schedules for checkout and Owner acceptance.
- C. The Divisions 21 through 23 Contractor shall include as part of the work of this contract, manpower, equipment, tools, ladders, instruments, etc. necessary to confirm start-up of Divisions 21 through 23 systems.
- D. The Division 23 05 93, Test, Adjust and Balancing Contractor shall include as part of the work of his/her contract, labor and material to provide manpower, equipment, tools, ladders, instruments, etc. necessary to assist the Start-Up Coordinator in accomplishing his/her work.
- E. The Start-Up Coordinator shall be responsible for maintaining documentation of Start-Up activities until final acceptance of the project.
- F. The documentation shall be kept current by the Start-Up Coordinator and shall be available for inspection at all times. At the time of acceptance of the project, the Start-Up Coordinator shall surrender 3 completed copies of the documentation to the Owner's representative.
- G. Before Testing, Adjusting, Calibration and Balancing (Division 23 05 93), the Start-Up Coordinator shall confirm, in writing to the Owner, the following:
 - 1. All equipment, components, and systems have been set, started-up, and adjusted.
 - 2. Systems have been established at the appropriate temperatures and pressures for proper operation and performance.
 - 3. All electric power connections, disconnects, fuses, circuit breakers, etc. are properly sized and installed.
 - 4. The operation of all valves, dampers and sensors is positive (per the control sequences) and demonstrated.
- H. Provide dated matrices for each item of equipment showing the date each of the start-up activities was witnessed or performed by the Start-Up Coordinator.
 - 1. Start-up and operating performance test documentation shall include all Division 21 through 23 equipment with scheduled capacities and all Division 23 09 00 equipment.

- I. At the completion of the start-up; and test and balance, Divisions 21 through 23 shall conduct a 72 hour dynamic mode demonstration of the systems in the presence of the Owner and Architect/Engineer.

3.9 DEMONSTRATION

- A. Refer to Division 1 sections of the specifications regarding requirements of Record Drawings and Operation and Maintenance Manual submittal and systems demonstration.
 - 1. Demonstrate to the Architect/Engineer that each system operates in accordance with the contract documents.
 - 2. Explain the operation of each system to the Owner's Representative. Explain use of O&M manual in operating and maintaining systems.
- B. Date and time of demonstration will be determined by Owner.

3.10 PROJECT CLOSEOUT

- A. Refer to the individual sections of the specifications for individual closeout requirements.
- B. Provide all documentation required for LEED certification.
- C. Provide a written schedule of when systems are to be started up, tested and demonstrated along with dates for completion of the temperature controls and balancing. This schedule shall be submitted no later than 30 days prior to starting up and testing equipment.
- D. The contractor shall notify the Architect/Engineer no later than 2 weeks in advance of system testing or demonstration.

3.11 LEED

- A. During construction meet or exceed the recommended Control Measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 1995, Chapter 3, as summarized below:
 - 1. HVAC Protection – Use temporary heaters whenever feasible. Seal all duct and equipment openings with plastic. If permanently installed air handlers are used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of 8, as determined by ASHRAE 52.2-1999, shall be used over each return air grille. Replace all filtration media immediately prior to occupancy. All leaks in ducts and air handlers should be repaired promptly.
 - 2. Source Control – For Contractor information, all paints, carpet, caulks, adhesives, sealants are specified as low-VOC and non-toxic. Recover, isolate and ventilate

- containers housing toxic materials. Avoid exhaust fumes from idling vehicles and gasoline fueled tools.
3. Pathway Interruption – During construction, isolate areas of work to prevent contamination of clean or spaces. Ventilate using 100% outside air to exhaust contaminated air directly to the outside during installation of VOC emitting materials. Use pressure differentials or barriers between work and clean areas to prevent contaminated air from entering clean areas.
 4. Housekeeping – Protect building materials from weather and store in a clean area prior to unpacking for installation. Clean all coils, air filters, and fans before performing testing and balancing procedures. Institute cleaning activities designed to control contaminants in building spaces.
 5. Scheduling – Complete applications of wet and odorous materials such as VOCs in paints, sealants, and coatings before installing absorbing materials such as ceiling tiles, carpets, insulation, gypsum products, and fabric-covered furnishings. Avoid exposure of all interior materials to moisture.
 6. Protect stored on-site or installed absorptive materials from moisture damage.
- B. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total air volume of 14,000 cu.ft. of outdoor air per sq.ft. of floor area while maintaining an internal temperature of at least 60 degrees F and relative humidity no higher than 60%.
1. Contractors option: Either full continuous flush-out or air contaminant testing is required, not both,
 2. For building flushout, perform building flush-out before occupancy and after construction is complete, HVAC systems have been tested, adjusted, and balanced, and new filtration media has been installed. Perform a building flush-out by supplying a total air volume of 14,000 cu.ft. of outdoor air per sq.ft. of floor area while maintaining an internal temperature of at least 60 degrees F and relative humidity no higher than 60%. If interior spaces must be occupied prior to completion of the flush-out, supply a minimum of 25% of the total air volume prior to occupancy and provide minimum outside air volumes of 0.30 cfm per square foot or design minimum outside air rate, whichever is greater. Install new HVAC filtration media after completion of flush-out and before occupancy or further testing. OR
 3. For Air Contaminant testing, perform air contaminant testing prior to occupancy, after interior finishes are installed, HVAC system has been tested, adjusted, and balanced, and new HVAC filtration media has been installed. Collect indoor air samples representative of occupied areas. Collect samples at outside air intake of each air handler at the same time as indoor samples are taken. Analyze air samples and submit report. If air samples show concentrations higher than those specified, ventilate with 100% outside air and retest, or conduct full building flushout as specified above.
 4. Air Contaminant Concentration Determination and Limits:
 - a. Carbon monoxide: not more than 9 ppm and not more than 2 ppm higher than outdoor air.
 - b. Formaldehyde: Not more than 50 ppb and not more than 20 micrograms per cubic meter higher than outside air.

- c. Total Volatile Organic Compounds: Not more than 500 micrograms per cubic meter and not more than 200 micrograms per cubic meter higher than outside air.
 - d. 4-Phenylcyclohexene: Not more than 6.5 micrograms per cubic meter.
 - e. Particulates: Not more than 50 micrograms per cubic meter.
 - f. Total Particulates: Not more than 20 micrograms per cubic meter higher than outside air.
- C. Construction waste management: Manage construction waste in accordance with provisions of Division 1. Submit documentation to satisfy the requirements of that section.

END OF SECTION 23 05 02

SECTION 23 05 03 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. This Section supplements Division 1, General Requirements.
- B. Where contradictions occur between this Section and Division 1, the more stringent of the two shall apply. The design team shall decide which is more stringent.
- C. Provisions of this Section shall also apply to all Sections of Divisions 21 through 23.

1.2 SUMMARY

- A. Furnish and install complete electric heat tracing systems as specified herein and as indicated on the mechanical and plumbing drawings. Heat Trace systems shall be installed to maintain the product UL listing with strict conformance to manufacturer's installation requirements.
- B. The Division 23 contractor shall be responsible for fully functional and complete heat trace systems. Refer to specification section 23 05 01 Mechanical and Electrical Coordination for heat trace system scope responsibility.

1.3 SUBMITTALS

- A. Manufacturer's Data - Submit manufacturer's data for:
 - 1. Access panels.
 - 2. Fire stopping materials.
 - a. Application Data - Submit application data for firestopping materials showing UL required installation details for every combination of pipe material, penetrated structure, opening size and required fire rating within the scope of this project. Application data drawings shall include UL system number.
 - 3. Heat Trace.
 - a. Submit shop drawings for review prior to installation. Shop drawings shall show the overall system, component product data, each control location, cable lengths, electrical connection requirements, and electrical feed points. Provide a summary sheet of the entire system with capacity data for each cable length.

B. LEED:

1. Adhesives and Sealants:

- a. Submit product data or other published information verifying the VOC (Volatile Organic Compound) content is less than or equal to the allowable VOC content established by the governing standard: South Coast Air Quality Management District (SCAQMD) Rule #1168, July 1, 2005 and Green Seal Standard for Commercial Adhesives GS-36, October 19, 2000.

2. Low-Emitting Paints and Coatings:

- a. Submit product data or other published information verifying the VOC (Volatile Organic Compound) content is less than or equal to the allowable VOC content established by the governing standards: Green Seal Standard GS-11, Paints, First Edition, May 20, 1993; Green Seal Standard GC-03, Anti-Corrosive Paints, Second Edition, January 7, 1997; South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, January 1, 2004.

PART 2 - PRODUCTS

2.1 ACCESS PANELS

A. See Division 8 for access panel types and finishes.

1. If panels are not specified in Division 8, comply with the following:

a. Manufacturers:

- 1) Acudor
- 2) Karp Associates, Inc.
- 3) Milcor
- 4) Zurn.

B. Construction:

- 1. Doors: 14-gauge steel.
- 2. Frames: 16-gauge steel.
- 3. Fire Rating: Equivalent to construction in which installed.
- 4. Latches: Flush or concealed, ¼ turn.
- 5. Finish: Compatible with finish of construction in which installed.

2.2 FIRE STOPPING MATERIAL

A. Manufacturers:

1. Design Basis: 3M.
2. Other acceptable manufacturers:
 - a. GE
 - b. Metalines
 - c. Hilti

B. General Requirements:

1. Products to be used shall have been tested in accordance with ASTM E 814-88, and be listed in the UL Fire Resistance Directory.

C. Bare Piping:

1. Model: FD 150, or CP-25.

D. Insulated Piping:

1. Model: CP-25 or FS-195, Intumescent.
2. "No-sag" or "self-leveling" as required.

E. Plastic Piping:

1. Model: CP-25 or FS-195, Intumescent.
2. "No sag" or "self-leveling" as required.

F. Accessories:

1. Provide fasteners, restricting collars, backing materials, and protective coatings as required to comply with the UL system listing.

2.3 ACOUSTICAL/PRESSURE SEALING MATERIAL

A. Manufacturers:

1. Manufacturers:
 - a. D.A.P. Mono Acoustical Sealant
 - b. GE
 - c. Metacaulk
 - d. Hilti
 - e. Pecora

- f. Tremco
- g. U.S.G.

B. General Requirements:

- 1. Non-skinning, non-hardening synthetic butyl rubber.
- 2. Effective adhesive seal for air and vapor barrier.
- 3. Acceptable for use in air plenums.

C. Accessories:

- 1. Provide fasteners and backing rods as recommended by manufacturer.

2.4 HEAT TRACE FOR PIPING FREEZE PROTECTION IN WATER PIPING AND FIRE PROTECTION SYSTEMS

A. Manufacturers:

- 1. Design Basis: Raychem/Pentair.
 - a. Model: XL-Trace
- 2. Other acceptable manufacturers:
 - a. Chromalox
 - b. Thermon
 - c. Emerson/Nelson

B. General Requirements:

- 1. Intent of heat trace system is to prevent freezing of fluid inside piping.
- 2. For fire protection systems, this specification is applicable to fire protection supply lines and standpipes only.
- 3. Heat tracing system shall be designed to maintain the water temperature within the piping of at least 40°F with an ambient temperature of -20°F (60 °F ΔT). The piping shall be insulated as specified in section 23 07 00 Mechanical Insulation.
- 4. Heat trace circuits shall be limited to a single piped utility only. Where multiple piped utilities in the same location are required to be heat traced, provide separately controlled circuits for each piped utility (i.e. domestic cold water, domestic hot water/recirculation, chilled water, etc. are each on separately controlled heat trace circuits). Domestic hot water and domestic hot water recirculation are allowed to be on the same heat trace circuit. Fire Sprinkler piping heat trace systems shall be dedicated to fire sprinkler piping only.

C. Heat Trace System Requirements:

1. Heating cables shall be UL listed and FM approved electrical heating strips. The electric heat tracing shall be a self-regulating type of parallel circuit construction consisting of a continuous inner core of self-regulating conductive material between two parallel copper bus wires suitable for operation on 277-Volt, 60 hertz, single phase power. Heat trace to be self-regulating at all points of connection and shall be capable of being overlapped or installed on plastic piping without overheating. The heat tracing strips shall be capable of being cut to the desired length in the field. Operating energy shall be conserved by the self-regulating feature of the heater materials, which automatically controls heat output in proportion to the heat requirement. Maximum operating temperature and exposure temperature shall be 150°F. Minimum installation temperature shall be 0°F.
2. The heat trace system shall include all required components for a fully functional system including heating cable, power connection, splice connections, tee connections, end seals, controls, contactors, power distribution panels, glass cloth adhesive tape, aluminum tape, accessories, and tools required for installation. Components shall be specific to the application (i.e. above ground or below ground), pipe material, and insulation type. Heat traced piping shall be labeled "Electric Traced" with permanent labeling. Provide one label per 10 feet of pipe.
3. Above ground piping:
 - a. Provide polyolefin jacket on heat trace cables.
 - b. Non-fire protection systems: Heat Trace system shall be UL listed and FM approved for above ground general water piping freeze protection applications. Provide all components, connections, and accessories to maintain UL listing.
 - c. Fire protection supply lines: Heat Trace system shall be UL listed for above ground fire protection supply line freeze protection applications. Provide all components, connections, and accessories to maintain UL listing. Comply fully with NFPA 13.
 - d. Fire protection standpipes: Heat Trace system shall be UL listed for above ground fire protection standpipe freeze protection applications. Provide all components, connections, and accessories to maintain UL listing. Comply fully with NFPA 13.
4. Below ground piping:
 - a. Provide fluoropolymer jacket on heat trace cables.
 - b. Non-fire protection systems: Heat Trace system shall be UL listed and FM approved for below ground general water piping freeze protection applications. Provide all components, connections, and accessories to maintain UL listing.
 - c. Fire protection supply lines: Heat Trace system shall be UL listed and FM approved for below ground fire protection supply line freeze protection applications. Provide all components, connections, and accessories to maintain UL listing. Comply fully with NFPA 13.
 - d. Heating cables shall be protected from the pipe to the power connection box in UL listed water-sealed conduit, minimum ¾" diameter, suitable for location where installed.
 - e. Power connections and end seals shall be made above ground within UL listed junction boxes or manufacturer's connection kits.

- f. Closed cell, waterproof thermal insulation with fire-retardant, waterproof covering approved for direct burial is required. Refer to Section 23 07 00 Mechanical Insulation for additional requirements.

D. Heat Trace Circuits:

- Heat trace circuit quantity for 277V/1PH systems shall be based on maximum cable lengths below. All heat trace cabling shall be served by 20A GFEP circuit breakers. Where multiple cables are required, all cables may be on the same circuit as long as maximum total cable length is not exceeded. Tables below are based on the basis of design heat trace product installed on metallic or plastic piping with insulation as specified. For fluids over 200°F, provide insulation thickness per section 230700 Mechanical Insulation and select cabling as recommended by heat trace system manufacturer.

Heat Trace Circuits for Metallic Piping Systems with Fluids 200°F and less – 277V/1PH				
Pipe Size (Metallic Pipe)	Insulation Thickness	Design Heat Loss in Watts per linear foot	Cable Quantity and Power Output at 40°F Maintain Temperature and 60°F ΔT (Watts per linear foot)	Maximum Total Cable Length per circuit at -20°F startup temperature, 277V/1PH, 20A GFEP Circuit Breaker
½" and ¾"	1-1/2"	1.82 W/lf	(1) cable at 7.2 W/lf	245 ft.
1"	1-1/2"	2.06 W/lf	(1) cable at 7.2 W/lf	245 ft.
1-1/4"	2"	1.96 W/lf	(1) cable at 7.2 W/lf	245 ft.
1-1/2"	2"	2.18 W/lf	(1) cable at 7.2 W/lf	245 ft.
2"	2"	2.44 W/lf	(1) cable at 7.2 W/lf	245 ft.
2-1/2"	2"	2.8 W/lf	(1) cable at 7.2 W/lf	245 ft.
3"	2"	3.18 W/lf	(1) cable at 7.2 W/lf	245 ft.
4"	2"	3.8 W/lf	(1) cable at 7.2 W/lf	245 ft.
6"	2"	5.12 W/lf	(1) cable at 7.2 W/lf	245 ft.
8"	2"	6.34 W/lf	(1) cable at 7.2 W/lf	245 ft.
10"	2"	7.66 W/lf	(2) cables at 7.2 W/lf each	245 ft.
12"	2"	8.88 W/lf	(2) cables at 7.2 W/lf each	245 ft.
14"	2"	9.62 W/lf	(2) cables at 7.2 W/lf each	245 ft.
16"	2"	10.84 W/lf	(2) cables at 7.2 W/lf each	245 ft.
18"	2"	12.06 W/lf	(2) cables at 7.2 W/lf each	245 ft.
20"	2"	13.28 W/lf	(2) cables at 7.2 W/lf each	245 ft.

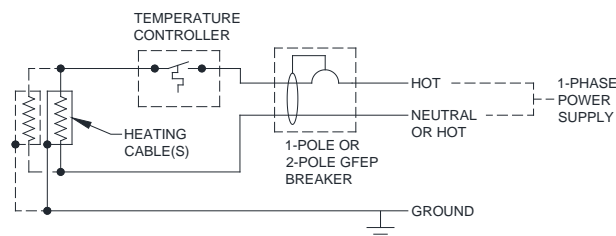
Heat Trace Circuits for Plastic Piping Systems with Fluids 200°F and less – 277V/1PH				
Pipe Size (Plastic Pipe)	Insulation Thickness	Design Heat Loss in Watts per linear foot	Cable Quantity and Power Output at 40°F Maintain Temperature and 60°F ΔT (Watts per linear foot)	Maximum Total Cable Length per circuit at -20°F startup temperature, 277V/1PH, 20A GFEP Circuit Breaker
½" and ¾"	1-1/2"	1.82 W/lf	(1) cable at 5.4 W/lf	245 ft.
1"	1-1/2"	2.06 W/lf	(1) cable at 5.4 W/lf	245 ft.
1-1/4"	2"	1.96 W/lf	(1) cable at 5.4 W/lf	245 ft.
1-1/2"	2"	2.18 W/lf	(1) cable at 5.4 W/lf	245 ft.
2"	2"	2.44 W/lf	(1) cable at 5.4 W/lf	245 ft.
2-1/2"	2"	2.8 W/lf	(1) cable at 5.4 W/lf	245 ft.
3"	2"	3.18 W/lf	(1) cable at 5.4 W/lf	245 ft.
4"	2"	3.8 W/lf	(1) cable at 5.4 W/lf	245 ft.
6"	2"	5.12 W/lf	(1) cable at 5.4 W/lf	245 ft.
8"	2"	6.34 W/lf	(2) cables at 5.4 W/lf each	245 ft.
10"	2"	7.66 W/lf	(2) cables at 5.4 W/lf each	245 ft.
12"	2"	8.88 W/lf	(2) cables at 5.4 W/lf each	245 ft.
14"	2"	9.62 W/lf	(2) cables at 5.4 W/lf each	245 ft.
16"	2"	10.84 W/lf	(2) cables at 8.1 W/lf each	194 ft.

Heat Trace Circuits for Plastic Piping Systems with Fluids 200°F and less – 277V/1PH				
Pipe Size (Plastic Pipe)	Insulation Thickness	Design Heat Loss in Watts per linear foot	Cable Quantity and Power Output at 40°F Maintain Temperature and 60°F ΔT (Watts per linear foot)	Maximum Total Cable Length per circuit at -20°F startup temperature, 277V/1PH, 20A GFEP Circuit Breaker
18"	2"	12.06 W/lf	(2) cables at 8.1 W/lf each	194 ft.
20"	2-1/2"	10.94 W/lf	(2) cables at 8.1 W/lf each	194 ft.

Adjust heat trace cabling power output and circuit quantity as required for design voltage, piping material, insulation type, insulation thickness, and selected manufacturer's maximum cable lengths.

E. Controls and Power Distribution:

1. Each heat trace circuit shall be served by a dedicated heat trace controller:
 - a. Provide microprocessor-based single-point heat trace electronic controller with programmable keypad and integral ground-fault protection. Basis of design: Raychem C910-485.
 - b. Controller shall include internal trip functionality and shall comply fully with the NEC.
 - c. Controller shall be NEMA 4X rated with ambient operating temperature range of -40°F to 140°F and relative humidity range of 0% to 90% non-condensing.
 - d. Controller shall include local LED indicator lights to indicate when heater is on and when an alarm condition exists.
 - e. Controller shall include an isolated solid-state triac relay and a dry contact relay for alarm annunciation.
 - f. Controller shall be capable of detecting and reporting a ground fault, ambient temperature or piping temperature, and system current. Controller shall automatically conduct periodic testing of system for faults and shall alert the BMS when a fault is detected.
 - g. Controller shall be wired in a single circuit control configuration with the controller mounted in series with the heating cable. Wiring shall be per manufacturer's recommendations.
 - h. Total heat trace circuit capacity may not exceed the current rating of the heat trace controller.
 - i. Power Wiring Diagram:



2. Control Methodology:
 - a. Provide 3-wire 100-ohm platinum resistance temperature detector (RTD) for ambient-sensing control of heat trace system.
 - b. RTD to be installed in same space as heat traced piping and wired to heat trace controller per manufacturer's recommendations. RTD shall measure ambient air temperature near heat traced piping system. Where system is larger than 75 linear feet, provide two RTDs wired to heat trace controller and mounted at the 1/3 and 2/3 distances of the heat traced piping run.
 - c. For heat trace installed on fire protection piping systems: Provide wired connection from heat trace controller to fire alarm control panel for alarm indication to fire alarm system. Comply fully with NFPA 13.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Quality Coordination: Where excavation and backfill for mechanical work passes through or occurs in the same area as work specified in Division 2, comply with both the requirements of Division 2 and the requirements of this Section, or whichever is the more stringent (as determined by the Architect/Engineer in cases of conflicting requirements).
- B. Inspection:
 1. Examine the areas to be excavated, and the conditions under which the work is to be performed.
 2. Notify the Architect/Engineer in writing of conditions detrimental to the proper completion of the work.
 3. Do not proceed with excavating until unsatisfactory conditions have been corrected.
- C. General:
 1. Do not excavate for mechanical work until the work is ready to proceed without delay, so that the total time lapse from excavation to completion of backfilling will be minimum.
 2. Remove all rock and boulders from excavation before installing mechanical work.
 3. Slope sides of excavations as required for stability, or provide necessary shoring.
 4. Remove shoring during backfilling.
 5. Excavate near large trees (within the drip line) by hand.
 - a. Protect the root system from damage or drying to the greatest extent possible.
 - b. Maintain moist condition for root system and cover exposed roots with burlap.
 - c. Paint root cuts of 1" diameter and larger with asphaltic tree paint.
 6. Saw-cut asphalt and concrete surfaces.

- D. Existing Utilities: Locate and protect existing utilities and other underground work in a manner which will ensure that no damage or service interruption will result from excavating and backfilling.
- E. Depth of Excavation:
1. Depth for Exterior Piping: Except as otherwise indicated, excavate for exterior piping so that the vertical distance between top of piping and finished grade will not be less than that prescribed by code.
 2. Excavate for exterior water-bearing piping (water, steam condensate, drainage) so that the vertical distance between top of piping and finished grade will not be less than 5'0" vertical distance below finished grade.
 3. Depth for Unsatisfactory Soil Conditions:
 - a. Where directed, because of unsatisfactory soil condition at bottom of excavation, excavate additional depth as directed to reach satisfactory soil-bearing condition. Backfill with "squeegee" washed rock, or other approved sub-base material, compacted as directed, to indicated excavation depth.
 - b. Where piping crosses over an area more than 5'0" wide, which has been previously excavated to a greater depth than required for the piping installation:
 - 1) Excavate to undisturbed soil in a width equal to the pipe diameter plus 2'0".
 - 2) Install "squeegee" washed rock, or 8" courses of approved subbase material; each course compacted to 95% of maximum density, as required to fill excavation and support piping.
 - c. Refer to Change Order procedure elsewhere in Contract Documents.
- F. Protection:
1. Provide temporary covering or enclosure and temporary heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install mechanical work on frozen excavation bases or subbases.
 2. Coordinate excavations with weather conditions, to minimize the possibility of washouts, settlements and other damages and hazards.
 3. Allow no more than 100 feet between pipe laying and point of complete backfilling.
 4. Maintain dry excavations for mechanical work by removing water.
 - a. Protect excavations from inflow of surface water.
 - b. Pump minor inflow of ground water from excavations.
 - c. Protect excavations from major inflow of ground water by installing temporary sheeting and waterproofing.
 - d. Provide adequate barriers which will protect other excavations and below-grade property from being damaged by water, sediment or erosion from or through mechanical work excavations.

5. Provide signs, illumination and barricades as necessary to prevent accidents at excavations.
6. Install and operate a well-point dewatering system to maintain ground water at a level approximately 2'0" below mechanical work excavations, until backfilling is completed.

G. Excavated Material:

1. Store excavated material (temporarily) near the excavation, in a manner which will not interfere with or damage the excavation or other work. Do not store under trees (within the drip line).
2. Retain excavated material which complies with the requirements for backfill material.
3. Remove excavated material which is either in excess of quantity needed for backfilling or does not comply with requirements for backfill material from project site, and dispose of in a lawful manner.
4. Coordinate acceptable stockpiling areas with Owner in advance of excavation.

H. Bedding:

1. Where indicated below, install as bedding material graded sand with 100% passing through a 3/8" sieve, and 0% passing through No. 100 sieve.
 - a. Compact by tamping to form a firm base for the work.
 - b. Install bedding from six inches below bottom of pipe to six inches above top of pipe.
 - c. Provide bedding for:
 - 1) Wrapped, coated or plastic pipe and tanks.
 - 2) Piping over six inches, horizontal cylindrical tanks, and similar work.
 - a) Shape the subbase to fit the shape of the bottom 90° of the cylinder, for uniform continuous support.
 - 3) All water and sewer pipe.
2. Where rock is used as sub-base, place 8-mil polyethylene between rock and bedding.
3. Shape sub-bases and bottoms of excavations with recesses to receive pipe bells, flange connection, valves and similar enlargements in the piping systems.

- I. Concrete Encasement: Where piping under roadways is less than 2'6" below surface of roadway, or where ductwork is buried below grade:
1. Provide 4" base slab of concrete to support piping and ductwork.
 2. After piping or ductwork is installed and tested, provide 4" thick encasement (sides and top) of concrete before backfilling.
 - a. Provide external structural reinforcing of all rectilinear cross section ductwork or any ductwork which is less than 18 ga sheet metal (or equivalent) to prevent collapse of ductwork encasement.
 3. Provide minimum 2500 psi concrete for encasement and slab.
- J. Backfilling:
1. Do not backfill until installed mechanical work has been tested and accepted, wherever testing is indicated.
 2. Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to the required densities.
 3. Do not backfill with frozen soil materials.
 4. Backfill simultaneously on opposite sides of mechanical work, and compact simultaneously.
 5. Do not dislocate the work from installed positions.
 6. Backfill to elevations matching adjacent grades, at the time of backfilling excavations for mechanical work.
 7. Backfill with finely graded sub-base material to 6" above wrapped, coated, and plastic piping and tanks, and to centerline of other tanks.
 8. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the densities indicated in Division 2 using power-driven, hand-operated compaction equipment.
 9. If densities are not indicated in Division 2, compact to the following percent of maximum per ASTM D1557:
 - a. Lawn/Landscaped Areas: 85%.
 - b. Paved Areas, Other than Roadways: 90%.
 - c. Roadways: 95%.
 - d. Floors: 95%.
 10. Where compaction tests indicate lower densities of backfill than specified, continue compaction (and re-excavation and backfilling where necessary).
 - a. Provide additional testing as directed by the Architect/Engineer.
 - b. The allowable density tolerance is not more than one-test-out-of-five failing more than two percentage points below the specified density.
 - c. Initial testing is not work of this Section.

11. Where subsidence is measurable or observable at mechanical work excavations during the guarantee period:
 - a. Remove the surface (pavement, lawn or other finish).
 - b. Add backfill material, compact, and replace the surface treatment.
 - c. Restore the appearance, quality and condition of the surface or finish to match adjacent work.
 - d. Eliminate evidence of the restoration to the greatest extent possible.

K. Landscape Restoration:

1. Where excavation and backfill for mechanical work passes through or occurs in a landscaped area, repair or replace the landscape work to match the original condition and quality of the work.
2. Comply with the requirements of Division 2 for repair or replacement of work, and for follow-up maintenance on lawns and planting to ensure satisfactory recovery.

L. Pavement Restoration:

1. Where excavation and backfill for mechanical work passes through or occurs in an area of paving or flooring, replace and restore the construction and finish of the paving or flooring to match the original condition and quality of the work.

M. Surface Repairs:

1. The repairing and replacing of previously installed landscape development work, paving, floor slabs and similar finishes occurring in excavated areas shall be provided, but is not included in work of Divisions 21 through 23.

3.2 CUTTING AND PATCHING

- A. Refer to Division 1 of the Specifications.
- B. General: Provide measurements, drawings and layouts to installers of other work so that required openings may be provided as construction progresses. Any cutting and patching made necessary by failure to provide this information shall be done at no increase in the contract amount.
- C. General: All cutting and patching of existing work required for work of Divisions 21 through 23 is included in Divisions 21 through 23.
- D. Where possible, mark openings to be cut on existing construction. Otherwise, provide measurements, drawings and layouts to the trade doing the cutting so that openings may be provided as construction progresses.

E. Cutting Concrete:

1. Where authorized, cut openings through concrete for pipe penetration and similar services by core drilling or sawing.
2. Do not cut by hammer-driven chisel or drill.

F. Cutting:

1. Cut openings in accordance with layouts, measurements or drawings of the Installer of work requiring openings. Cut openings in concrete by core drilling or sawing; not by hammer-driven chisel or drill.
2. Coordinate the location of all openings with structural drawings. Report any discrepancies to Architect. Do not proceed with work until discrepancies have been resolved.
3. Do not endanger or damage other work through the procedures and processes of cutting to accommodate mechanical work.
4. Review the proposed cutting with the Installer of the work to be cut, and comply with his recommendations to minimize damage.
5. Where necessary, engage the original Installer or other specialists to execute the cutting in the recommended manner.

G. Patching:

1. Where patching is required to restore other work because of either cutting or other damage inflicted during the installation of mechanical work, engage experienced craftsmen to complete the patching of the other work.
2. Restore the other work in every respect, including the elimination of visual defects in exposed finishes.
3. All openings in fire rated construction shall be patched and sealed with U.L. approved sealant to maintain the fire integrity of the structure.

H. Perform cutting, and patching required to:

1. Uncover work to provide installation of ill-timed work.
2. Remove and replace defective work.
3. Remove and replace work not conforming to requirements of the Contract Documents.
4. Remove samples of installed work as specified for testing.
5. Install equipment and materials in existing structures.
6. Upon written instructions from the Architect/Engineer, uncover and restore work to provide for Architect/Engineers observation of concealed work.

I. Painting: Paint all surfaces marred by cutting and/or patching to match existing.

1. Engage experienced painters.
2. Comply with requirements of Painting Sections of this Specification.

J. Structural Limitations:

1. Do not cut or drill into structural framing, walls, floors, decks, and other members intended to withstand stress, except with Engineer's written authorization.
 - a. Provide lintels, columns, braces and other temporary and permanent supports made by cutting.
 - b. Submit shop drawings of permanent supports.
 - c. Do not penetrate legs of structural "T's" or any other location where pre-stressed structural chords are likely to be encountered when cutting or drilling.

3.3 ACCESS PANELS

- A. Furnish access panels where indicated and at locations where required for access to:
1. Concealed valves
 2. Dampers
 3. Control devices
 4. Equipment servicing
 5. Shock arresters
 6. Air vents
 7. Flow measuring and balancing stations
 8. Any other device or item equipment requiring maintenance, adjustment or service.
- B. Deliver access panels for installation by the trade responsible for surface in which installed.
1. Provide instructions for location.
 2. Access doors shall be sized as required to allow equipment removal, with a minimum size of 12"x12".

3.4 SLEEVES

- A. Provide sleeves for piping passing through walls, floors and roofs.
- B. Set pipe sleeves and inserts in place before concrete is poured. Coordinate the placing of these items to avoid delaying concrete placing operations.
- C. Locate chases, shafts, and openings required for the installation of the mechanical work during framing of the structure. Do any additional cutting and boring required due to improperly located or omitted openings without cost to the Owner under the supervision of the Owner's representative.
- D. Size sleeves for below grade pipe a minimum of 2" beyond outside of pipe.

E. Provide Sleeves as Follows:

<u>Sleeve Location</u>	<u>Sleeve Material</u>
Interior Stud Partition Walls	Adjustable galvanized sheet metal with wall flanges and plaster lip, 2" and smaller – 22 gauge, 3" through 6" – 20 gauge, 8" and larger – 18 gauge.
Membrane Waterproof Floor and Roof Construction	Galvanized cast iron body with flashing clamp, threaded for sleeve riser. (J.R. Smith 1760 or equivalent by Ancon, Zurn or Josam).
Nonmembrane Floor, Construction	Non-adjustable galvanized sheet metal with deck flange and end cap, 2" and smaller – 22 gauge, 3" – 20 gauge, 4" and larger – 16 gauge.
Exterior Walls Below Grade	Standard weight galvanized steel pipe with a continuously welded water stop of ¼" steel plate extending from outside of sleeve a minimum of 2" all around. Provide modular mechanical-type seal consisting of interlocking synthetic rubber links with bolts shaped to continuously fill the annular space between the pipe and sleeve. Thunderline Corporation "Link-Seal" sealant assembly or equal by Metraflex "MetaSeal".
Floors of Mechanical Rooms, Concrete Walls or Masonry Walls Above Grade.	Standard weight galvanized steel pipe.

F. Length of Sleeves as Follows:

<u>Location</u>	<u>Sleeve Length</u>
Floors	Equal to depth of floor construction including finish. Extend minimum of 1" above finished floor level within partitions, mechanical rooms, pipe chases and finished areas.
Roofs	Equal to depth of roof construction including insulation.
Walls	Equal to depth of construction.

3.5 FIRE STOPPING

- A. Install firestopping materials in accordance with their UL and ASTM tested methods.
- B. Coordinate required annular space with size of pipe and sleeve. Refer to Section 23 05 22.
- C. Requirements for specific systems:
 1. Cold piping - includes chilled water, domestic water, storm water and refrigerant: Insulation and vapor barrier shall be continued through wall and firestopping for "insulated piping" shall be provided.

2. Hot piping - to 250°F -includes domestic hot water, steam to 15 psig and heating hot water: The Contractor has the option of continuing the insulation through the penetration and providing firestopping for “insulated piping”, or stopping the insulation on either side of the penetration and using firestopping for “uninsulated piping”.
3. High temperature piping, over 250°F or over 15 psig steam: Contractor shall stop insulation and provide firestopping for “high temperature piping”.

3.6 HEAT TRACE

- A. Furnish and install a complete electric heating cable system as indicated on the mechanical and plumbing drawings.
- B. Heat trace cable shall be installed by a licensed electrician.
- C. Heat trace systems shall be installed per manufacturer’s requirements in order to maintain system agency listings.
- D. Minimum installation temperature shall be 0°F. Do not apply heat trace when pipe temperature, roof temperature, gutter temperature, or downspout temperature is below 0°F.
- E. Apply the heat trace cable on the pipe after pressure testing.
 1. Do not spiral wrap on pipe.
 2. Make one wrap at valves.
 3. Secure to pipe with methods approved by manufacturer.
- F. Apply “Electrically Traced” signs on outside of insulation for heat traced piping. Provide one sign for every 10’ of pipe length.
- G. Heating cable circuit integrity shall be tested using a 2500 VDC megohmmeter at the following intervals. Minimum acceptable insulation resistance shall be 1000 megohms or greater.
 1. Before installing the heating cable
 2. After heating cable has been installed onto the pipe
 3. After installing connection kits
 4. After the thermal insulation is installed onto the pipe
 5. Prior to startup
- H. Heat trace shall be sized based on the application, and power shall be provided in accordance with manufacturer’s recommendations for circuit quantity and power distribution.
- I. Do not locate heat trace controllers in Class 1, Division 2 hazardous areas.
- J. Startup shall be conducted by manufacturer’s representative.

3.7 EQUIPMENT BASES AND SUPPORTS

- A. Supporting Steel: Provide supporting steel not indicated on the Structural Drawings for equipment, pipe, ductwork, and other pieces of this Division's work requiring same.
1. Submit shop drawings and structural calculations to the Engineer for information and records.
 2. Brace and fasten with flanges bolted to structure.
 3. Paint supporting steel with one coat of primer paint in the shop after fabrication welding is complete. Paint completed field joints with one coat of matching primer.
- B. Housekeeping Bases:
1. Concrete bases for pumps, boilers, tanks, fans, etc., including anchor bolts and inserts, will be provided in accordance with American Concrete Institute (ACI) and American Society for Testing and Materials (ASTM) Standards for housekeeping pads and equipment support bases.
 2. The concrete shall be placed in accordance with setting diagrams and sizes furnished by the equipment installer.
- C. Roof Curbs
1. All roof-mounted equipment to be provided with a roof curb in accordance with applicable codes and manufacturer's installation instructions. Height of curb to be a minimum of 14" or higher if required by local codes.
 2. Curb height is defined as the dimension between finished roof level (inclusive any buildup of insulation, roofing materials, etc.) and the bottom of the associated equipment.

3.8 DRIP PANS

- A. Drip Pans: Where possible to run mechanical piping elsewhere, do not run mechanical piping directly above electrical (or electronic) work which is sensitive to moisture. Otherwise, provide drip pans under mechanical piping, sufficient to protect electrical work from dripping.
1. Locate pan immediately below piping, and extend a minimum of 6" on each side of piping and lengthwise 18" beyond equipment being protected.
 2. Fabricate pans 2" deep of reinforced sheet metal with rolled edges and soldered or welded seams; 22-gauge galvanized steel.
 3. Provide 3/4" copper drainage piping from pan to nearest floor drain or similar suitable point of discharge, and terminate pipe as an open-sight drainage connection.
 4. Provide permanent support and anchorage to prevent displacement of drip pans.
 5. Insulate bottom of pan as directed by Engineer.

3.9 LEED

- A. Construction Indoor Air Quality Management: Manage indoor air quality in accordance with applicable LEED requirements.
- B. Construction Waste Management and Disposal: Manage construction waste in accordance with applicable LEED requirements.
- C. Paints and coatings must comply with Green Seal Standard GS-11, Green Seal Standard GC-03, and South Coast Air Quality Management District Rule 1113.

END OF SECTION 23 05 03

SECTION 23 05 13 - MOTORS AND STARTERS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data.

1. Motors: Identify by unit served. Include:

- a. Voltage
- b. Phase
- c. Horsepower
- d. Frame
- e. Insulating class
- f. Efficiency
- g. Power factor
- h. Index number
- i. Speed
- j. Starting characteristics

2. Starters: Identify by motor served. Include:

- a. Enclosure, NEMA Type
- b. NEMA size
- c. Accessories, switches, transformers, etc.
- d. Wiring diagram
- e. Auxiliary contacts
- f. Thermal overload size

3. Submit as part of packaged unit submittals when purchased as part of item of equipment.

1.2 SINGLE MANUFACTURER

- A. Provide all motors, except those factory mounted, by a single manufacturer.
- B. Provide all starters, except those factory mounted, by a single manufacturer.
- C. "Factory mounted" means "as part of a packaged unit" where the motor is not purchased separately from the driven equipment.

PART 2 - PRODUCTS

2.1 MOTORS (OTHER THAN FACTORY MOUNTED)

A. Manufacturers:

1. Manufacturers:

- a. Century
- b. General Electric
- c. Louis Allis
- d. U.S. Motor
- e. Westinghouse

2. Factory-mounted motors may be by equipment manufacturer's standard supplier.

B. Bearings: Ball bearings, grease lubricated with grease fittings.

C. Enclosure: As required by location.

D. Service Factor: 1.15.

E. Full-Load Operation: At 105°F and altitude of project.

F. Insulation:

- 1. Constant Speed: Class B.
- 2. Variable Frequency Controlled: Class F.

G. Efficiency Ratings:

- 1. All motors one horsepower and larger, except as noted, shall be premium efficiency motors, in accordance with NEMA Standard MGI-2003, Tables 12-12 and 12-13.

H. Electrical Characteristics:

- 1. Refer to sections 230501, Mechanical and Electrical Coordination.

I. Multi-speed Motors:

- 1. Type: Motors may be one of the following:
 - a. Two speed, two winding 1800/900 rpm.
 - b. Two speed, one winding 1800/900 rpm.

J. Variable Speed Drives:

1. All motors operated by a variable speed drive shall be rated for inverter duty.
2. Motor insulation shall be rated for 1200-Volt peak.
3. Provide shaft grounding Aegis SGR or equal on motors to be used with variable speed drives.

2.2 MOTORS (FACTORY MOUNTED)

A. Provide premium efficiency motors.

B. Variable Speed Drives:

1. All motors operated by a variable speed drive shall be rated for inverter duty.
2. Motor insulation shall have 1200-Volt peak capacity.
3. Provide shaft grounding or insulated bearings on motors to be used with variable speed drives.

2.3 STARTERS

A. Manufacturers:

1. Allen Bradley
2. Cerus
3. Cutler-Hammer
4. General Electric
5. Square D

B. General:

1. Starters shall be standard NEMA sizes and UL listed.

C. Type: Across the line except where noted.

D. Enclosure: NEMA Type as required for location.

E. Overload Protection:

1. Type: Trip-free thermal overload relay.
2. Location: Each ungrounded conductor.
3. Reset: Manual.
4. Ambient Temperature Compensation: Provide where required.
5. Overload protection to be sized for nameplate running amps.

F. Auxiliary Contacts:

1. Provisions to add three without removing starter from enclosure.
2. Number: Provide up to three per starter as required for control sequence, and one (1) auxiliary contact.
3. Switchable type, easily changed from N.O. to N.C. without removing from its mounting.

G. Switches in Cover:

1. Manually Controlled: Three wire start-stop.
2. Automatically Controlled: Hand-off-automatic.
3. Start and stop indicating lights.
4. Equipment used for life safety (smoke exhaust, etc.): Hand-Automatic.
5. Equipment not designed to run continuously: Off-Automatic.

H. Control Transformer:

1. Provide when line voltage exceeds 208-Volts.
2. Secondary wiring shall have one leg fused and the other grounded.
3. Secondary voltage not to exceed 120-Volts.

I. Provide starters for all motors as follows:

1. Single phase motors less than ½ hp.
 - a. With internal overload protection: None.
 - b. Without internal overload protection:
 - 1) Manually Controlled: Manual starter.
 - 2) Automatically Controlled: Magnetic starter.
2. Single phase motors ½ hp and larger:
 - a. Manually Controlled: Manual starter.
 - b. Automatically Controlled: Magnetic starter.
3. Three Phase Motors: Magnetic starter.

J. Soft Start Starters:

1. Provide Y-Delta or solid state reduced-voltage starters for all motors 5hp and larger.
2. Starter shall limit starting voltage to 200% of full load voltage.

K. Multi-Speed Starters:

1. Starters shall be suitable for the type multi-speed motor selected.
2. Provide time delay for automatic transfer from high to low speed.

- L. Housing coils to be 120V.
- M. Motor Protection: (above 20 hp)
 - 1. Provide Single-phase protection.
 - 2. Provide undervoltage protection.

PART 3 - EXECUTION

3.1 MOTORS

- A. Install motors on motor-mounting systems so coupling or belt drive is properly aligned. Provide proper belt tension. Dowel direct coupled motors.

3.2 STARTERS

- A. Deliver to installer of electrical work.
- B. All safety devices shall be wired so that they will stop the motor with a hand-off-automatic switch in the hand as well as the automatic position.

END OF SECTION 23 05 13

SECTION 23 05 21 - PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

- A. Welder Qualifications: Welders, both on-site and off-site, shall be certified for the type of work being performed by one of the following:
 - 1. National Certified Pipe Welding Bureau.
 - 2. Intermountain Testing Company
- B. Welder Certificates:
 - 1. Submit one copy of certificate to Architect/Engineer.
 - 2. Maintain one copy on project site.
- C. LEED:
 - 1. Adhesives and Sealants:
 - a. Submit product data or other published information verifying the VOC (Volatile Organic Compound) content is less than or equal to the allowable VOC content established by the governing standard: South Coast Air Quality Management District (SCAQMD) Rule #1168, July 1, 2005 and Green Seal Standard for Commercial Adhesives GS-36, October 19, 2000.
 - 2. Low-Emitting Paints and Coatings:
 - a. Submit product data or other published information verifying the VOC (Volatile Organic Compound) content is less than or equal to the allowable VOC content established by the governing standards: Green Seal Standard GS-11, Paints, First Edition, May 20, 1993; Green Seal Standard GC-03, Anti-Corrosive Paints, Second Edition, January 7, 1997; South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, January 1, 2004.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Refer to the following sections:

1. 21 13 00 - Fire Protection
2. 22 10 00 - Plumbing Piping
3. 22 21 23 - Natural Gas Piping
4. 23 21 13 - Hydronic Piping
5. Other Divisions 21 through 23 sections after specific system requirements.

2.2 GROOVED PIPE COUPLING SYSTEMS

A. Manufacturers of Coupling System:

1. Basis of Design: Victaulic
2. Other Acceptable Manufacturers: Grinnell and Gruvlok. Alternate is to provide a system of standard weight black steel pipe with black steel standard weight butt weld or 125 lb. cast iron flanged fittings.
3. All couplings, gaskets and joining method adapters shall be provided by one manufacturer.
4. Training: A factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation.

B. Dimensional Standards:

1. All grooved pipe fittings, couplings, and specialties shall conform to standard dimensional standards ANSI/ANWA C-606 or MIL-P-11087C.

C. Acceptable Products:

1. Only the following grooved pipe products may be used:
 - a. Gaskets: (ASTM D2000) EHP, for water service, with or without propylene glycol -30°F to 250°F, primary seal by compression of coupling housing, either pressure or vacuum shall assist in sealing force.
 - b. Couplings - Steel Pipe: Ductile iron (ASTM A-536) or malleable iron (ASTM A-47), with enamel paint coating.
 - 1) Rigid Couplings: Style 107, 07, W07 zero flex.
 - 2) Flexible Couplings: Style 177, 77, W77.

- c. Flange Adapters: Same materials as couplings. Provide for rigid connection to grooved pipe. Provide flange washers and/or flange gaskets as required for mating to non-standard flanges, such as butterfly valves with elastomeric face, or serrated face flanges.
 - 1) ANSI Class 125 or 150: Style 741.
 - 2) ANSI Class 300: Style 743.
 - 3) Alternate to flange adapter: Flange by groove nipple #41 (Class 125), #45 (Class 150), #16 (Class 300).
 - d. Branch Outlet Couplings: Design similar to coupling with integral side outlet.
 - e. Fittings for steel pipe: Standard pattern fittings, ductile iron (ASTM A-536), malleable iron (ASTM A-47) or segmentally welded Schedule 40 steel (ASTM A-53) with enamel paint coating. All changes in direction greater than 22° shall be with R=1.5D radius elbow. All branches and changes in direction in drainage piping shall be made with sanitary type lateral branches and R=1.5D elbows.
 - f. Accessories: Other piping accessories such as strainers, suction diffusers and flow indicators may be provided with grooved ends, all such accessories shall comply with the applicable specification section.
2. All other pipe products shall conform to the requirements of other Divisions 21 through 23 sections. Acceptance of grooved pipe systems does not imply acceptance of the coupling manufactures valves, branch outlets, strainers, or other specialties.

2.3 PRESS FIT JOINING SYSTEM

A. Manufacturer

- 1. Viega ProPress
- 2. Nibco Press System
- 3. Other approved manufacturer

B. Material

- 1. Press Fittings: Copper press fittings. Must comply with ASME B16.18 or B16.22.
- 2. O-Rings: EPDM
- 3. Fittings shall be rated for 0°F to 250°F, and 200 psi.

C. Application

- 1. Domestic Water, 4" and smaller
- 2. Hydronic Systems, 4" and smaller

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. General:

1. Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure.
2. Install each run with a minimum of joints and couplings, but with adequate and accessible unions for disassembly, maintenance or replacement of valves and equipment.
3. Reduce sizes by use of reducing fittings.
4. Install piping without springing or forcing.
5. Provide sufficient swing joints, anchors, expansion loops and devices necessary to permit free expansion and contraction without causing undue stresses.
6. Support piping independently at equipment so its weight will not be supported by the equipment.
7. Support piping to maintain a consistent slope as indicated on the drawings without sagging or pocketing of any kind. Where not otherwise indicated, all horizontal piping shall slope a minimum of 1/16 inch per foot to drain at system low points.
8. Provide manual air vents at high points of all pumped piping systems. Provide drains at all low points.
9. Install horizontal piping parallel to building construction, make any changes in direction with fittings.

B. Location:

1. Locate piping runs, except as otherwise indicated, both vertically and horizontally to allow for complete drainage of piping system (pitched to drain).
 - a. Avoid diagonal runs wherever possible.
 - b. Orient horizontal runs parallel with walls and column lines.
2. Hold piping close to walls, overhead construction, columns and other structural and permanent-enclosure elements of the building.
 - a. Limit clearance to 0.5" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any.
 - b. Where possible, locate insulated piping for 1.0" clearance outside insulation.
3. Wherever possible in finished and occupied spaces, conceal piping from view by locating in column enclosures, in hollow wall construction or above suspended ceilings.
 - a. Do not encase horizontal runs in solid partitions, except as otherwise indicated.

- C. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures.
 - 1. Exception: where shown on drawings or where accepted by the Engineer, provide drip pan under piping, and conform to NEC.
 - 2. In no case shall piping run directly above transformers, electrical panels or switchgear.
- D. Dielectric Unions: Install dielectric unions to prevent galvanic action between ferrous and non-ferrous piping.
 - 1. Install in an accessible location or provide access doors.

3.2 PLASTIC PIPE

- A. Use:
 - 1. Contractor shall take full responsibility that the plastic piping used and its installation meets with the approval of the local authorities.
 - 2. Pipe shall be insulated in air plenums such that the entire installation meets ASTM E84 (NFPA 255) with regard to flame spread and smoke developed ratings suitable for plenum installation.
 - 3. Provide pipe with U.V. inhibitors or paint (under Division 9):
 - a. For all plastic pipe exposed to sunlight or installed in exterior, exposed locations.
 - b. Store PVC without inhibitors indoors.

3.3 WELDING

- A. Welding:
 - 1. Conform to Code for Pressure Piping ANSI B31.
 - 2. Machine cut and bevel piping ends for v-type joints.
 - 3. Use recommended bevels and spacing between ends of pipe to assure full penetration complete to inside diameter of pipe.
- B. Welded Joints:
 - 1. Will be observed visually by the Architect/Engineer.
 - 2. Any weld judged defective from a visual observation, shall be ordered tested at the expense of the Contractor or chipped out for full depth and re-welded.

C. Welding Fittings:

1. Unless otherwise noted, make all changes in direction and branch take offs with manufactured fittings.
 - a. Use long radius (R=1.50) fittings wherever possible.
2. Shop Fabricated Fittings:
 - a. Branches more than two pipe sizes smaller than main line may be made with “weld-o-let” type pre-manufactured saddle fittings.
 - b. Where specifically allowed by the Engineer, angles of less than $22\frac{1}{2}^{\circ}$ and branch piping from headers may be made by shop fabricated or manufactured metered fittings.
 - c. Submit shop drawings.
 - d. Thoroughly clean fittings to remove slag.
 - e. Fittings shall be available for observation by the engineer prior to installation.
3. In no case will field made miters or weld-o-let fittings be allowed. Exception:
Temperature control wells and water treatment taps may be made with weld-o-let fittings in pipe 3” or larger in diameter.

3.4 COPPER TUBING JOINTS AND FITTINGS

- A. Unless otherwise noted, make all couplings, changes in direction, branch outlets, and transitions to other materials or joining methods with standard manufactured fittings.
- B. Do not expand or swage piping in lieu of proper solder fittings.
- C. Do not extrude or “pull” branch outlets with “tee-drill” type equipment.
- D. Do not use self-tapping type branch outlets.
 1. See “hot taps” below.

3.5 THREADED JOINTS AND FITTINGS

- A. All threaded joints shall be made in accordance with American National Standard B2.1.
 1. Do not overthread pipe.
 2. Apply pipe joint compound on male threads only.
 3. Do not use right and left hand threaded joints to make a “union”.
- B. Do not thread steel pipe schedule 10 or lighter.
 1. UL listed light wall pipe may be threaded in accordance with its listing.

3.6 MECHANICAL COUPLING SYSTEMS

- A. All changes in direction shall be made with radius type elbows.
 - 1. Use long radius ($R=1.5D$) fittings wherever possible.
 - 2. Angles less than $22\frac{1}{2}^\circ$ may be made with pre-manufactured metered fittings.
 - 3. Use of the angular deflection capabilities of grooved pipe couplings for intentional changes of direction shall not be allowed.
- B. All branch outlets shall be made with pre-manufactured 3-way fittings.
 - 1. Shop fabricated Weld-o-let style welded saddle fittings may be used for branches more than two pipe sizes smaller than the main.
 - 2. Mechanical saddle tap fittings shall not be allowed.
- C. Pipe shall be adequately laterally supported to prevent "pipe squirm". Provide a minimum of one hanger per pipe section. No pipe section shall be left unsupported between any two couplings.
 - 1. Rigid type couplings may be considered equivalent to welded or soldered pipe for the above requirements.
- D. Risers more than 20' high shall be made with rigid type couplings.
- E. Grooved pipe systems shall not be considered to be electrically conductive.
 - 1. Provide wire jumpers across all couplings where the piping system is required to be electrically conductive.
 - 2. Cold water piping using grooved pipe systems shall not be used for building ground.
 - a. Provide an engraved plastic sign at the building water entrance stating, "Mechanical Coupling System". Not Electrically Conductive".
- F. Flexible couplings may be used for thermal expansion/contraction compensation.
 - 1. Use a minimum of 1 flexible coupling for every 100 feet for chilled water and domestic cold-water piping.
 - 2. Use a minimum of 1 flexible coupling for every 50 feet for hydronic hot water or domestic hot-water piping.
 - 3. The above is for cut grooved pipe. Double the amount of the connectors with roll grooved pipe and fittings.

3.7 PRESS FIT SYSTEMS

- A. Fittings and piping shall be joined in accordance with manufacturer's installation guidelines.
 - 1. Tubing shall be fully inserted into fitting.
 - 2. Mark all tubes at shoulder of fitting.
 - 3. Press joints using manufacturer approved tool.

3.8 HOT TAPS

- A. Installing a branch line in piping while under service or static pressure (hot taps) shall only be done where specifically authorized.
- B. Submit the proposed method of procedure for each fluid service and pipe material.
 - 1. Hot tap procedure shall remove a plug of main tap material and retrieve it. The plug shall be a maximum of 1 pipe size smaller than the branch size. Hang the removed plug by a chain at the completed tap.
 - 2. Hot tap procedure shall not affect the temperature or pressure rating of the piping system.
 - 3. Hot tap procedure shall be done through a gate or ball valve.

3.9 SENSOR WELL TAPS

- A. Sensor wells shall be placed in taps made in accordance with the above requirements for branch outlets.

3.10 CLEANING, FLUSHING, INSPECTING

- A. Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings, if any.
- B. Flush out water and piping systems with clean water before proceeding with required tests.
- C. See specific pipe service section for further requirements.

3.11 PIPING TESTS

- A. Provide temporary equipment for testing, including pump, thermometer and gauges.
- B. Test piping system before insulation is installed wherever feasible, and remove control devices before testing.
- C. Test each natural section of each piping system independently, but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating.

- D. Fill each section of water, drain or vent piping with water and pressurize for two hours at 150% of operating pressure, but not less than 25 psig for pressure piping, and ten feet of head for drain and vent piping.
- E. Test fails if leakage is observed, or if temperature compensated pressure drop exceeds 1% of test pressure.
- F. Disassemble and re-install sections which fail the test by using new materials to the extent required to overcome leakage.
 - 1. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
- G. After testing and repair work have been completed, drain test water from piping systems.

3.12 MECHANICALLY FORMED TEE CONNECTIONS (DOMESTIC WATER SYSTEMS ONLY)

- A. Mechanically extracted collars shall be formed in a continuous operation consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the branch tube wall so as to comply with the American Welding Society lap joint weld. The collaring device shall be fully adjustable as to ensure proper tolerance and complete uniformity of the joint.
- B. The branch tube shall be notched to conform with the inner curve of the run tube and have two dimple/depth stops (one 1/4" atop the other) to ensure penetration of the branch tube into the collar is of sufficient depth for brazing, and that the branch tube does not obstruct the flow in the main line tube. Dimple/depth stops will be in line with the run of the tube. The second dimple shall be 1/4" above the first and will serve as a visual point of inspection.
- C. All joints shall be brazed in accordance with the Copper Development Association Copper Tube Handbook using BCuP series filler metal. NOTE: Soft soldered joints will not be permitted. Contractor assumes responsibility for joints being installed in accordance with code and manufacturer's recommendation.
- D. All mechanically formed branch collars shall be listed by the Standard Plumbing Code, I.A.M.P.O., S.B.C.C. HUD, U.S. Army Corps of Engineers, NAVFAC, and Underwriters Laboratory. They shall also comply with the ASME Code for pressure Piping ANSI B31.5c.

3.13 PLASTIC PIPING

- A. Do not test with air pressure.
- B. Provide mineral wool fire blanket and tape sealant system to protect all plastic pipe in a return air system.
- C. Support all plastic piping in anticipation of 120°F pipe temperature.

3.14 PAINTING

- A. Exposed piping shall be painted. Pipe shall be cleaned by this contractor and ready for priming and painting.

END OF SECTION 23 05 21

SECTION 23 05 22 - PIPING ACCESSORIES

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Manufacturer's Data - Piping Accessories: Submit manufacturer's data on the following piping accessories:
 - 1. Sealing compound for sleeves.
 - 2. Expansion compensators.
 - 3. Flexible pipe connections.
 - 4. Guides.
- B. LEED:
 - 1. Adhesives and Sealants:
 - a. Submit product data or other published information verifying the VOC (Volatile Organic Compound) content is less than or equal to the allowable VOC content established by the governing standard: South Coast Air Quality Management District (SCAQMD) Rule #1168, July 1, 2005 and Green Seal Standard for Commercial Adhesives GS-36, October 19, 2000.
 - 2. Low-Emitting Paints and Coatings:
 - a. Submit product data or other published information verifying the VOC (Volatile Organic Compound) content is less than or equal to the allowable VOC content established by the governing standards: Green Seal Standard GS-11, Paints, First Edition, May 20, 1993; Green Seal Standard GC-03, Anti-Corrosive Paints, Second Edition, January 7, 1997; South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, January 1, 2004.

PART 2 - PRODUCTS

2.1 MANUFACTURED PRODUCTS

- A. Escutcheon Plates:
 - 1. Type: Split ring
 - 2. Construction: Brass

3. Finish:
 - a. At Painted Surfaces: Prime coat
 - b. At Other Surfaces: Nickel or Chrome plate
4. For Floor Sleeves: Where sleeves extend above floor surface, provide depth to cover sleeve.

B. Flexible Pipe Connectors, Rubber Type:

1. Manufacturers - Design Basis: Mason
2. Other Acceptable Manufacturers:
 - a. Flexicraft
 - b. Keflex
 - c. Metraflex
3. Material: Two sphere EPDM construction with reinforcing ring.
4. Model: MFTNC, Twin Sphere 225 psi.

C. Flexible Pipe Connectors, Braided Hose:

1. Manufacturers - Design Basis: Mason
2. Other Acceptable Manufacturers:
 - a. Flexicraft
 - b. Keflex
 - c. Metraflex
3. Material: Stainless steel braid with carbon steel connectors, threaded or flanged.

2.2 FABRICATED ACCESSORIES

- A. Steel-Pipe Sleeves: Fabricate from Schedule 40 steel pipe. Remove burrs.
- B. Iron-Pipe Sleeves: Fabricate from service weight cast-iron pipe. Remove burrs.
- C. Sheet-Metal Pipe Sleeves: Fabricate from galvanized sheet-metal, closed with lock-seam joints.
 1. For following pipe sizes, provide gauge indicated:
 - a. Three-Inch Pipe and Smaller: 20 gauge
 - b. Four-Inch to Six-Inch Pipe: 16 gauge
 - c. Over Six-Inch Pipe: 14 gauge

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pipe Sleeves:

1. Install pipe sleeves where piping passes through walls, floors, ceilings, roofs and structural members, except soil pipe penetrations through concrete slab on grade.
2. Where possible pour sleeve in place or grout.
3. Provide sleeves of adequate size, accurately centered on pipe runs, so that piping and insulation (if any) will have free movement in the sleeve in non-fire rated penetrations.
4. In fire rated penetrations, size sleeves such that the resulting annular space is in accordance with the application requirements of the fire stopping system. Refer to Section 23 05 03. All above grade floor penetrations shall be considered to be fire-rated.
5. Install length of sleeve equal to thickness of construction penetrated, except extend floor sleeves 0.25" above floor finish and, where floor surface drains to a floor drain, extend floor sleeve 0.75" above floor finish.
6. Provide temporary support of sleeves during placement of concrete and other work around sleeves.
7. Provide temporary closure to prevent concrete and other materials from entering pipe sleeves.
8. Except as otherwise indicated, install steel pipe sleeves.
9. At interior partitions and ceiling, install sheet metal sleeves.
10. At exterior penetrations below grade, install iron pipe sleeves.
11. Seal exterior sleeve penetrations at grade weather tight.

B. Caulking:

1. Where water seal or sound seal, but not fire seal, is needed, (foundation walls, slab on grade): fiberglass backing and heavy bead of silicone caulking compound.
2. Where sleeve pierces a fire separation: Fire stop material in accordance with manufacturer's directions and UL listing. Refer to Section 23 05 03.

C. Install escutcheon plates at pipe sleeves where piping is exposed to view in occupied spaces of the building, on the exterior, and elsewhere as indicated.

D. Compensators: Install where shown or where required because piping arrangement does not provide sufficient flexibility.

1. Protect compensators from over-travel and over-stress during remaining installation and testing.

E. Flexible Connectors: Install at right angles to displacement.

1. Install one end immediately adjacent to isolated equipment and anchor other end.

- F. Guides: Install where shown and where required in accordance with expansion compensators published requirements.
1. As a minimum, install one guide within four pipe diameters of compensator, and one guide 14 pipe diameters from first guide.

END OF SECTION 23 05 22

SECTION 23 05 23 - VALVES

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Manufacturer's Data: Submit manufacturer's product data including:
 - 1. Dimensions
 - 2. Sizes
 - 3. End Connections
 - 4. Weights
 - 5. Installation instructions
 - 6. Instructions on repacking and repairing valves.
 - 7. Range of flow and full open (permanent) pressure loss for balancing valves and plug valves.
 - 8. Differential pressure tables for flow measurement at venturi type balancing valves.
- B. Valve Tag List: Refer to Section 23 05 53 of the Specifications.

PART 2 - PRODUCTS

2.1 VALVES TYPES AND SIZES

- A. General:
 - 1. Where type or body material is not indicated, provide valve with pressure class selected from MSS or ANSI standards, based on the maximum pressure and temperature in the piping system.
 - 2. All valves in contact with domestic water shall meet the requirements of NSF/ANSI Standard 61.
 - 3. Except for balancing or otherwise indicated, provide valve of same size as connecting pipe size.
 - 4. Ball valves or butterfly valves may be used in lieu of gate valves when pressure and temperature ratings are adequate.
 - 5. Where pipe sizes overlap, contractor has the option of threaded or flanged valves.
 - 6. Where grooved pipe mechanical coupling systems are accepted, provide flange adapters to mate with valves as specified below. Valves by the mechanical coupling system manufacturer shall not be used unless they meet all of the specified requirements for a given valve.
 - 7. All valves shall be domestically manufactured unless approved for use by Engineer.

8. Valves used for domestic water service shall be bronze or stainless steel. Iron and brass body valves are not acceptable.
9. All components in hydronic systems shall be compatible with propylene glycol and water solution.

B. Unless noted otherwise, the following table indicates valve types to be used for functions listed. Manufacturer listed is basis of design. Refer to specification section indicated for additional requirements.

Service	Chilled Water	Heating Hot Water	Domestic Hot and Cold Water
Shutoff/ Isolation	2-1/2" and larger: • Type BTV Butterfly Valve 2" and smaller: • Type BV Ball	2-1/2" and larger: • Type BTV Butterfly Valve 2" and smaller: • Type BV Ball	All sizes • Type BV Ball RE: 221000 Plumbing Piping
Check	2" and larger: • Type SWCV Silent/Wafer Check 1-1/2" and smaller: • Type SCV Swing Check	2" and larger: • Type SWCV Silent/Wafer Check 1-1/2" and smaller: • Type SCV Swing Check	2" and larger: • Type SWCV Silent/Wafer Check 1-1/2" and smaller: • Type SCV Swing Check RE: 221000 Plumbing Piping
Balance	2-1/2" and larger: • Type BLV Manual 2" and smaller: • Type BLV Manual	2-1/2" and larger: • Type BLV Manual 2" and smaller: • Type BLV Manual	All sizes • Type CS Circuit Setter RE: 221000 Plumbing Piping
Base Mounted Pump Discharge	All sizes: • Type TCS Combination Throttling/ Check Valve	All sizes: • Type TCS Combination Throttling/ Check Valve	N/A
Inline Pump Discharge	All sizes: • Type SWCV Silent/Wafer Check	All sizes: • Type SWCV Silent/Wafer Check	All sizes: • Type SWCV Silent/Wafer Check
Drain Valve	All sizes: • Type BV Ball	All sizes: • Type BV Ball	All sizes: • Type BV Ball
Bypass	RE: Shutoff/Isolation	RE: Shutoff/Isolation	RE: Shutoff/Isolation RE: 221000 Plumbing Piping

1. Refer to section 22 10 00 Plumbing Piping for additional Domestic Water valve specifications and requirements.
2. Refer to Division 22 specifications for additional system valves and specialties not indicated in table above.

2.2 GLOBE AND ANGLE VALVES – TYPE GAV

A. Manufacturers:

1. Design Basis: Milwaukee
2. Other Acceptable Manufacturers:
 - a. Crane
 - b. Gruvlok

- c. Nibco
 - d. Powell
 - e. Stockham
 - f. Victaulic (for Grooved Pipe Systems)
- B. Size 2" and Smaller: Bronze, 125 psi SWP, 200 psi WOG, rising stem, screwed bonnet. Bronze disk, MSS SP-80, Type 1.
 - 1. Model:
 - a. Globe, Solder Ends: 1502
 - b. Globe, Threaded Ends: 502
 - c. Angle: 504
- C. Size 2½" and Larger: 125 psi SWP, 200 psi WOG, OS&Y bolted bonnet, gland packed, bronze disk, removable bronze seat ring, MSS SP-85.
 - 1. Model:
 - a. Globe: F-2981

2.3 SWING CHECK VALVES – TYPE SCV

- A. Manufacturers:
 - 1. Design Basis: Milwaukee
 - 2. Other Acceptable Manufacturers:
 - a. Crane
 - b. Gruvlock
 - c. Nibco
 - d. Powell
 - e. Stockham
 - f. Victaulic (for Grooved Pipe Systems)
- B. Size 2" and Smaller: Bronze, 200 psi SWP, 400 psi WOG, straight or Y-pattern, Bronze Disk, MSS-SP80 Type 3.
 - 1. Model: 508
- C. Valves used for domestic water service shall be ANSI/NSF-61 certified.

2.4 SILENT/WAFER CHECK VALVES – TYPE SWCV

A. Manufacturers:

1. Design Basis: Metra Flex
2. Other Acceptable Manufacturers:
 - a. Cla-Val
 - b. GA Industries
 - c. Gruvlok
 - d. Nibco
 - e. Stockham
 - f. Tyco
 - g. Victaulic (for Grooved Pipe Systems)

B. Size 2" and Smaller: Bronze body, 200 psi @ 250 °F, threaded ends, resilient seats, center guided disk.

1. Model: 5700

C. Pipe size 2 1/2 " and Larger: Iron body, bronze or stainless-steel trim, class 125, 316 stainless-steel spring, dual plate or tilting disk type, resilient seat, minimum Cv: 4"-280, 8"-1200, 12"-4000.

1. Model: 810

D. Valves used for domestic water service shall be ANSI/NSF-61 certified.

2.5 BUTTERFLY VALVES – TYPE BTV

A. Manufacturers:

1. Design Basis: Keystone
2. Other Acceptable Manufacturers:
 - a. Bray
 - b. Center Line
 - c. Crane
 - d. Gruvlok
 - e. Hammond Watts
 - f. Keystone
 - g. Milwaukee
 - h. Nibco
 - i. Stockham
 - j. Victaulic (for Grooved Pipe Systems)

- B. Water Service (less than 250°F): 200 psi WOG, cast or ductile iron fully lugged body, integral extended neck to clear insulation, integral top plate for actuator mounting, stainless-steel stem, upper and lower lubricated bushings, field replaceable hard back seat with integral stem and flange seals, machined disk seating areas, rated for minimum 150 psi dead end service with no downstream flange. Liner to be compatible with operating fluid. Conform to MSS-SP67.
1. Disk Material - 8" and Under and all sizes for domestic water: Aluminum bronze.
 2. Disk Material, 10" and Larger: Nickel plated ductile iron.
 3. Model: Figure 2-22.
- C. Accessories:
1. 10 position locking lever handler for valves 6" and smaller.
 2. Infinite position memory stop lever handle for all valves 6" and smaller used for balancing.
 3. Hand wheel gear operator for valves 8" and larger.
 4. Chain wheel operator where required.

2.6 GATE VALVES – TYPE GTV

- A. Manufacturers:
1. Design Basis: Milwaukee
 2. Other Acceptable Manufacturers:
 - a. Crane
 - b. Gruvlok
 - c. Nibco
 - d. Stockham
 - e. Victaulic (for Grooved Pipe Systems)
- B. Size 2" and Smaller: Bronze 125 psi SWP, 200 psi WOG, rising stem, threaded bonnet, gland packed MSS SP-80 Type 2.
1. Model: 148
- C. Size 2½" and Larger: Cast iron, 125 psi SWP, 200 psi WOG, gland packed, bolted bonnet, OS&Y, solid wedge disk, either all bronze or with bronze face ring, bronze seat rings, brass back seat bushing, brass stem, bronze yoke bushing.
1. Model: F2885

2.7 BALL VALVES – TYPE BV

A. Manufacturers:

1. Design Basis: Nibco
2. Other Acceptable Manufacturers:
 - a. Apollo
 - b. Bray
 - c. Dyna Quip
 - d. Gruvlok
 - e. Hammond
 - f. Milwaukee
 - g. Stockham
 - h. Victaulic (for Grooved Pipe Systems)
 - i. Watts

B. Valve bodies must be cast bronze. Forged brass is not acceptable.

C. Bronze, 150, SWP, 600 WOG (min), chrome plated solid, tunneled bronze ball (stainless for steam service), two-piece design, blow-out proof stem, adjustable packing gland nut (allowing handle to be removed without leaking) TFE seats, MSS-SP-110.

1. Model: T-585-70 - full.port.

D. Valves used for domestic water service shall be ANSI/NSF-61 certified.

E. Options: Provide the following where required:

1. Extended stems for insulated valves.
2. Memory stop device for balancing applications.
3. Tee handle for tighter areas.
4. Hose end and cap for drain.
5. Mounting pads for actuator.

2.8 CIRCUIT SETTERS (CS) – DOMESTIC WATER APPLICATIONS ONLY – TYPE CS

A. Manufacturers:

1. Design Basis
 - a. Bell & Gossett/ITT

2. Acceptable Manufactures:
 - a. Victaulic
 - b. Prior Engineer Approval for Substitutions

B. Construction:

1. All valves to be of brass body/brass ball construction with glass and carbon-filled TFE seat rings. Valves to have differential pressure read-out ports across valve seat area. Read-out ports to be fitted with internal EPT insert and check valve. Valve bodies to have ¼" NPT tapped drain/purge port. Valves to have memory stop feature to allow valve to be closed for service and then reopened to set point without disturbing balance position. All valves to have calibrated nameplate to assure specific valve setting. Valves to be leak-tight at full rated working pressure.

C. Valves ½" to 2" pipe size, NPT or sweat valves 2 ½" and 3" pipe size, NPT.

D. Pressure/Temperature 175 psig at 250°F.

E. ANSI/NSF-61 certified.

2.9 COMBINATION THROTTLING/CHECK VALVES – TYPE TCS

A. Manufacturers:

1. Basis of Design: Bell & Gossett Triple Duty Valve.
2. Other Acceptable Manufacturers:
 - a. Armstrong
 - b. Taco
 - c. Victaulic (for Grooved Pipe Systems)
 - d. Watts

B. Features:

1. 175 psi, 250°F water working pressure.
2. Globe style valve with stainless-steel spring-loaded brass disk guided and limited by a brass or stainless-steel stem.
3. Resilient seat.
4. Able to be re-packed under pressure.

2.10 DRAIN VALVES – TYPE DV

- A. Ball valve with hose end adapter and cap.

2.11 PLUG VALVES – TYPE PV

- A. Manufacturers:
 - 1. Design Basis: Keystone
 - 2. Other Acceptable Manufacturers:
 - a. Dezurik
- B. Model: “Ballcentric”; cast-iron, full port body; EPDM coated plug; welded nickel seat; stainless-steel bearings; integral memory stop device; hand wheel operator for valves 6” and larger.

2.12 BALANCING VALVES – TYPE BLV

- A. Manufacturers:
 - 1. Design Basis: IMI Hydronic Engineering (Flow Design).
 - 2. Other Acceptable Manufacturers:
 - a. Armstrong
 - b. Griswold
 - c. Hays
 - d. Nexus
 - e. Nibco
 - f. NuTech
 - g. Tour and Andersson
- B. Manual Balancing Valves (1/2" through 2"):
 - 1. 400psi at 250°F, venturi type, with integral ball valve, brass body, EPDM O-ring seals, two pressure/temperature ports, and manual air vent. Memory stop with graduated markings. PTFE ball valve seats with blowout proof stem. Soldered or threaded connections.
 - 2. Each valve shall provide four (4) functions:
 - a. Precise flow measurement
 - b. Precision flow balancing
 - c. Positive shut-off with no drip seat, eliminating the need of an additional isolation valve.
 - d. Manual air venting.
- C. Balancing Valves (2-1/2” - 16"):
 - 1. 240 psi at 250°F, venturi type, with integral butterfly valve, steel body, and two pressure/temperature ports. Flanged connections.

2. Butterfly valve: 200 psi WOG, cast or ductile iron fully lugged body, lever handle, infinite position adjustment, memory stop, integral extended neck to clear insulation, stainless-steel stem, upper and lower lubricated bushings, field replaceable hard back seat with integral stem and flange seals, machined disk seating areas, rated for minimum 150 psi dead end service with no downstream flange. Liner to be compatible with operating fluid. Conform to MSS-SP67.
3. Butterfly Valve Disk: Aluminum Bronze.

PART 3 - EXECUTION

3.1 GENERAL

- A. Comply with the following requirements:
 1. Install valves except butterfly with stems pointing up, and as close to vertical as possible. Butterfly valves to be offset at least 10° from vertical.
 2. Install valves at each piece of equipment, fixture or appliance so that the supply and return services can be shut off to remove the item without draining the remainder of the piping system.
 3. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping.
 - a. Locate valves so as to be accessible.
 4. Combination balancing and shut-off valves may be used instead of a separate balancing valve and shut-off valve if the valve has a memory stop and the manufacturer lists its use as a leak-proof service valve.
 5. Provide drain valves at main shut-off valves, low points of piping and apparatus.
 6. Provide separate support where necessary.
 7. Do not allow meter connections of balancing valves to point downward.
 8. Install valves so bypass valves are accessible.
- B. All valves of a given type shall be of one manufacturer.
- C. Provide extended stems on insulated system to prevent interference of operator with insulation.
- D. Provide chain wheel operators for valves more than 8' – 0" AFF in mechanical rooms and wherever shown on drawings.

3.2 CHECK VALVE INSTALLATION

A. Swing and Check Valves:

1. Install only in horizontal lines unless absolutely impractical. If installed vertically, flow shall be upwards.
2. Do not install in pump discharge piping.

B. Silent Check Valves:

1. Silent check valves may be installed in vertical pipes with flow down upon Engineer's review for each instance.

3.3 VALVES USED FOR THROTTLING/BALANCING

- A. Balancing valves shall not be used for flow indication in pipes 2½" and larger, or in pump discharge piping.
- B. Flow indication in piping 2½" and larger and in pump discharge piping, shall be by a venturi with a plug, butterfly, or globe valve for throttling.
- C. Throttling/Balancing Valves shall be selected so that the maximum design flow causes between 1' and 10' W.G. pressure drop or meter reading with the valve wide open.
- D. Install balancing valves used for flow indication with a minimum of five times the pipe diameter downstream and two times the pipe diameter upstream of a fitting or valve.
- E. Globe, ball, butterfly, or plug valves may be used for throttling/balancing. Provide an infinitely variable, lockable memory stop device to allow the valve to be returned to the "balanced" position after closing, and to prevent movement of the disk or plug during operation. When ball valves are used for throttling, provide an additional valve for equipment isolation.
- F. Balancing valve sized to flow.
- G. Insulation: Provide pre-molded insulation conforming to the valve body. Material shall have a flame spread of 25 and a smoke development of 50.

3.4 COMBINATION THROTTLING/CHECK VALVES

- A. Combination throttling/check valves may be used in lieu of separate throttling and check valves on pump discharge piping. However, they may not be used for flow measurement.

3.5 CIRCUIT SETTERS

- A. All circuit setters shall be installed per manufactures recommendations. Provide manufacturers recommendation for required straight pipe for inlet and outlet connections to provide accurate ratings. Setting shall be 1 GPM unless otherwise noted on drawings.

END OF SECTION 23 05 23

SECTION 23 05 29 - PIPE SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 STANDARDS

- A. Comply with MSS Standard Practice SP-69, published by Manufacturer's Standardization Society of the Valve and Fitting Industry for type and size.

1.2 SUBMITTALS

- A. Submit manufacturer's product data on the following:
 - 1. Hangers other than clevis type.
 - 2. Anchors.
- B. Submit structural calculations on trapeze type supports.
- C. Submit product data and calculations to project structural engineer for review. Submittals shall document compliance with current Building Codes and maximum point loads listed in Structural plans.

PART 2 - PRODUCTS

2.1 PIPE HANGERS

- A. General:
 - 1. Use adjustable pipe hangers on suspended pipe. Trapeze hangers may be used at the Contractor's option. Contractor shall be responsible for sizing supports.
 - 2. Chain, wire or perforated strap hangers will not be permitted.
 - 3. Isolate hangers in contact with dissimilar materials with dielectric hanger liners. Tape is not acceptable.
 - 4. Provide supports between piping and building structure where necessary to prevent swaying.
- B. Hanger and Rod Material:
 - 1. Exposed in public areas: Zinc electroplated steel.
 - 2. Concealed or in service areas: Black threaded steel.
 - 3. Outside, exposed to weather: Hot dipped galvanized.
 - 4. Buried below structural slab: Stainless Steel

C. Cast-In- Place Inserts:

1. Cast-in-place inserts system shall be used.
2. Inserts to be UL and FM listed for their application.
3. Cast-In-Place Anchors shall be designed per ACI 318 Appendix D Strength Design methods as required by the IBC 2012 and ASCE 7-10. Where exempt from ACI 318 Appendix D, anchors shall be designed using Allowable Stress Service loads if allowed by the Building Code.
4. Cast In Place inserts shall be tested in accordance with current ICC-ES acceptance criteria A.C. 446 or ACI 355.2 where required.
5. Cast In Place inserts in concrete shall have a current ICC-ES or IAPMO-UES listed Research Report. Anchors shall be installed in strict accordance with approved ICC-ES or IAPMO-UES Research Report for the specific anchor used.
6. Threaded Inserts shall conform to ASTM A307.
7. Size inserts to match size of threaded hanger rods.
8. Manufacturers:
 - a. DEWALT Bang-It+, Wood-Knocker II+, or DDI+
 - b. Simpson Blue Banger Hanger

D. Channel Type Inserts:

1. Standard channel support with anchor tabs on 4" centers, and nail holes for attaching to forms.
2. Styrofoam inserts to prevent wet concrete seepage.
3. Minimum 2000 pounds/foot capacity.

E. Expansion Anchors or Screw Anchors:

1. For use only where modifications to piping layouts to change from pre-installed insert locations and only under approval from the Engineer.
2. Inserts shall be wedge-type or screw type and shall be designed per ACI 318 Appendix D Strength Design methods as required by the IBC 2012 and ASCE 7-10. Anchors shall be tested in accordance with current ICC-ES acceptance criteria A.C. 193 or ACI 355.2. Anchors in concrete shall have a current ICC-ES or IAPMO-UES listed Research Report. Anchors shall be installed in strict accordance with the approved ICC-ES or IAPMO-UES Research Report for the specific anchor used.
3. Manufacturers:
 - a. DEWALT Power-Stud+ SD2 or Screw-Bolt+
 - b. Hilti- Kwik-Bolt TZ
 - c. Simpson Strong Bolt 2 or Titen HD Rod Hanger
4. Power driven fasteners are not acceptable.
5. "Drop-in" type anchors are not acceptable.
6. Anchors shall be installed with all required nuts, washers.

7. Install anchors per Manufacturer's recommendations with proper torque values where required.
8. Interior: Carbon steel anchors complying with ASTM A307.
9. Exterior or Wet Environment: Series 300 stainless-steel anchors, nuts and washers.
10. Anchors shall comply with loading requirements as designated by the Engineer of Record or per the Building Code.

F. Steel Structure Attachments:

1. Contractor may select welded or mechanically attached. All mechanically attached supports shall have jam nuts or other means to prevent loosening. Maximum loading requirements are as follows:

<u>Rod Size</u>	<u>Maximum Working Load</u>
3/8	600 pounds
1/2	1100 pounds
5/8	1800 pounds
3/4	2700 pounds
7/8	3700 pounds

G. Single Hangers:

1. Piping 2" and smaller: MSS type 1, Clevis hanger or type 7 adjustable swivel ring hanger. Minimum 180 pounds design load.
2. Piping 2½" and larger: MSS type 1 Clevis hanger.
3. Bare copper pipe: Above hangers, plastic or Neoprene coating, sized for copper pipe O.D. and copper coated for identification.
4. Insulated pipe: Hangers to be sized for O.D. of insulation. Hangers shall not penetrate any insulation.

H. Trapeze hangers and wall supports:

1. Channel strut or structural steel shapes. Contractor shall follow channel strut manufacturers guidelines for loading or provide structural steel supports designed by a professional Engineer, licensed in the same state as where the project is located.
2. All piping shall be attached to the support by means of a channel strut clamp, U-bolt, or pipe rollers which will maintain lateral position of the pipe but allow longitudinal movement. Provide dielectric isolation between all dissimilar metals.
3. All insulation shall be continuous at supports. Do not notch or penetrate insulation.

I. Vertical Supports: Steel riser clamp at each floor penetration or every 14 foot supported from wall bracket. Do not anchor riser clamps.

J. Hangers:

1. General: Adjustable wrought steel clevis with locking nut attachment.
2. Multiple or Trapeze: Steel channels with welded spacers and hanger rods.

3. Hanger Sizes and Spacing:

- a. For gas, domestic water and drain piping, conform to the International Plumbing and Fuel Gas Codes for spacing, and the following table for hanger rod sizes.
- b. For hydronic piping, conform to the following table:

PIPE TYPE	PIPE SIZE	MAXIMUM SPACING	MINIMUM HANGER ROD SIZE
Steel Pipe	½"	6'-0"	3/8"
	¾" thru 1¼"	8'-0"	3/8"
	1½" and 2"	10'-0"	3/8"
	2½" thru 3½"	12'-0"	½"
	4" and 5"	15'-0"	5/8"
	6"	17'-0"	¾"
	*	8" thru 12"	7/8"
*	14" thru 18"	10'-0"	1¼"
*	20" thru 30"	8'-0"	1½"
Copper Pipe	½" thru 1"	6'-0"	3/8"
	1¼" thru 2"	10'-0"	3/8"
	2½" thru 3"	10'-0"	½"
Cast Iron Soil	2"		3/8"
	3" to 5"		½"
	6"		5/8"
*	8" to 12"		¾"

* Submit routing and support plans to Architect/Engineer for review.

K. Insulated Pipe Supports:

1. Size pipe supports for outside diameter of pipe insulation.

L. Wall Supports:

1. ½" through 3": Unistrut type channel and steel clamp.
 - a. Use Hydrosorb cushions on copper pipe.
2. 4" and Over: Welded steel bracket and wrought steel clamp.

M. Pipes over five inches and over 120°: Provide cast iron roller supports.

2.2 PIPE POSITIONING SYSTEMS AT FIXTURE LOCATIONS

A. Manufacturers:

1. Design Basis: Holdrite
2. Other Acceptable Manufacturers:
 - a. Sioux Chief
3. In-wall plumbing systems serving fixtures and equipment shall be properly supported to prevent movement or vibration. The use of construction scrap materials for the purpose of supporting pipe and equipment is not allowed. All materials shall be new and manufactured for the purpose of supporting pipe and equipment.

2.3 INSULATION INSERTS

- ### **A.**
- All insulated pipes shall be protected at the point of support by insulation inserts. Insert to be same thickness as adjoining pipe insulation. Materials shall be suitable for use in an air plenum.
- ### **B.**
- Provide any of the following products:
1. High density, 100 psi, waterproofed calcium silicate, encased in a sheet metal shield. Shield shall extend one inch beyond sheet metal shield. If pipe hanger spacing exceeds ten feet and for all pipe roller applications, utilize double layer shield on bearing surface.
 2. Trymer Polyisocyanurate Foam insulation (urethane). Provide compressive strength and temperature range as required for pipe served. Insert shall be provided with factory applied vapor barrier.
 - a. Manufacturers: Snapp Itz Mechanical Pipe Shields (BBMI, LLC) or pre-approved equal.
 - b. Not for use on steam piping or other piping above 225° F.
- ### **C.**
- Provide 180° insulation inserts when utilizing clevis hangers. Provide 360° insulation inserts at all trapeze and wall supports.

2.4 PIPE ANCHORS

A. Manufacturers:

1. Anvil
2. Cooper Industries B-Line
3. Mason
4. Metraflex

- B. Design Basis – Any of the following:
1. Pipe Riser Anchor Clamp: Metraflex Riser Anchor Clamp
 2. Low Load Anchor Clamp: Metraflex Model PA Anchor Clamp
 3. Pre-insulated Anchor Clamp: Metraflex Model PAPI
 4. Welded Structural W-Section Anchor: Metraflex Model PAI Structural I-beam Anchor
- C. Material:
1. Material in contact with pipe shall be steel for steel pipe, bronze for copper tubing. Where clamp anchors are a dissimilar metal to piping, provide FRP pad secured to the pipe with epoxy adhesive to prevent metal to metal contact between clamp and pipe.
- D. Anchors may be field fabricated similar to manufactured products specified.
- E. Submit pipe stress analysis for review prior to installation of pipe anchors.

2.5 PIPE GUIDES

- A. Manufacturers:
1. Adsko
 2. Anvil
 3. Cooper Industries B-Line
 4. Flexicraft
 5. Keflex
 6. Mason
 7. Metraflex
 8. PHD
- B. Design Basis – Any of the following:
1. Spider Type: Metraflex Style IV Spider Type guide
 2. Roller Type: Two sets of rollers on opposite sides of pipe
 3. Slide Type: Cooper Industries B-Line B3893 with hold down lugs (not for use with cold piping)
 4. Light duty, 1-1/2" and smaller copper: U-bolt or channel strut clamp allowing clearance from O.D. of pipe or insulation
 5. Pipe Riser Guides: Metraflex Modular Riser Guide
- C. Material: Material in contact with pipe shall be steel for steel pipe, bronze for copper tubing. Where guides are a dissimilar metal to piping, provide FRP pad secured to the pipe with epoxy adhesive to prevent metal to metal contact between guide and pipe.

2.6 EXPANSION COMPENSATORS

A. Expansion Compensators, Two Inch and Smaller, Loop Type:

1. Manufacturers - Design Basis: Metraflex
2. Other Acceptable Manufacturers:
 - a. Adsko
 - b. Flexicraft
 - c. Keflex
 - d. Mason
3. Model: Metraloop

B. Expansion Compensators, Bellows Type:

1. Manufacturers – Design Basis: Metraflex
2. Other Acceptable Manufacturers:
 - a. Adsko
 - b. Flexicraft
 - c. Keflex
 - d. Mason
3. Model: MNLC, 300 psi max. working pressure

2.7 ROOF-MOUNTED PIPING

A. Manufacturers:

1. B-Line Dura-Blok
2. Miro Industries, Inc.
3. PHD Manufacturing
4. PHP Systems/Design
5. Approved Equivalent.

B. Description: Piping on roof shall be supported by an engineered prefabricated portable pipe system specifically designed to be installed on the roof without roof penetrations, flashing or damage to the roofing material. The system shall consist of recycled rubber or plastic bases, hot dipped galvanized or stainless-steel frame with threaded rods and suitable pipe hangers and supports. The system shall be custom designed to fit the piping and conduits to be installed and the actual conditions of service.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE SUPPORTS

- A. Adequately support piping from the building structure with adjustable hangers to maintain uniform grading where required and to prevent sagging and pocketing.
 - 1. Provide supports between piping and building structure where necessary to prevent swaying.
 - 2. Do not support pipe from other pipe or equipment.
 - 3. Provide thrust restraints at all changes in direction on 8" and larger cast iron piping with no hub or hub and spigot fittings.
- B. Install hangers to provide minimum 1/2" clear space between finished covering and adjacent work.
 - 1. Place a hanger within one foot of each horizontal elbow.
 - 2. Space hangers generally as called for in Table in Part 2, Products.
- C. Use hangers, which are vertically adjustable 1-1/2" minimum after piping is erected.
- D. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
 - 1. Set inserts in position in advance of concrete work.
 - 2. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
 - 3. Do not penetrate concrete "TT" legs for piping inserts. Do not penetrate the stressed (i.e. lower) chords of any structural member.
- E. Expansion anchors or screw anchors: For use only where modifications to piping layouts to change from pre-installed insert locations and only under approval from the Engineer.
 - 1. Installation shall be in strict compliance with ICC-ES or IAPMO-UES Research Report criteria.
 - 2. Expansion anchors require periodic special inspection as required by their ICC-ES or IAPMO-UES Research Report.
 - 3. Special inspector shall make periodic inspections of installation for compliance with manufacturer's installation instructions.
- F. Provisions for Movement: Install hangers and supports:
 - 1. To allow controlled movement of piping systems.
 - 2. To permit proper movement between pipe anchors.
 - 3. To facilitate the action of expansion joints, expansion loops, bends and offsets.
 - 4. To isolate force due to weight or expansion from equipment connections.

- G. In general, attach hangers to upper chord of roof trusses and floor joists, using long rods to facilitate pipe movement.
- H. Anchors:
 - 1. Use no pipe anchors. Arrange piping such that pipe expansion and contraction is accommodated by controlled movement of the pipe within the pipe supports. Provide sufficient offsets in branch piping to accommodate movement of main piping due to expansion and contraction.

END OF SECTION 23 05 29

SECTION 23 05 30 - ELECTRONIC SPEED CONTROLLERS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Submit manufacturer's product data for each unit. Include:
 - 1. Capacity:
 - a. Horsepower
 - b. KVA
 - c. Amps
 - 2. Wiring Diagrams:
 - a. Include diagrams for basic unit and for all required accessories.
 - 3. Dimensions.
 - 4. Installation instructions.
 - 5. Description of diagnostic system.
 - 6. Options provided.
 - 7. Time-current curves for VFD circuit.
- B. Show compliance with IEEE 519 – provide harmonic analysis for project jobsite including total harmonic-voltage distortion and total harmonic current distortion (TDD). The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic-voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFDs shall include a minimum of 5% impedance reactors, no exceptions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Manufacturer:
 - 1. Manufacturers:
 - a. ABB
 - b. Cutler-Hammer
 - c. Danfoss
 - d. Eaton

- e. Franklin Controls Systems
- f. General Electric
- g. Hitachi
- h. Honeywell
- i. Magnetek
- j. Mitsubishi
- k. Reliance
- l. Robicon
- m. Square D
- n. Toshiba
- o. Trane
- p. Yaskawa

B. Single Manufacturer

- 1. Provide all drives, except those factory mounted, by a single manufacturer.
- 2. "Factory Mounted" means as part of a packaged unit where the drive is not purchased separately from the driven equipment.

C. Drive shall convert the constant frequency AC line voltage to a variable frequency, variable voltage AC output suitable for control of a standard NEMA design B induction motor over a 10:1 speed range and with full load amp rating between 10% and 110% of the drive full load current capability and without modification to the motor or the drive.

D. Variable frequency drives for motors greater than 5 HP shall have the following features:

- 1. Drive input: 480-Volts +/- 10%, 3 phase, 60 Hz, 65 KAIC minimum or as shown on electrical drawings.
- 2. Drive output: 0-460-Volts, 3 phase, 0-80 Hz. For efficient operation of a variable torque load.
- 3. Drive type: Pulse width modulation type, designed to minimize harmonic generated noise in the motor.
- 4. Enclosure type: NEMA 1 or NEMA 4 depending upon mounting location. Unit to operate in ambient temperatures of -40F to 155F. Where variable frequency drive is located in an area that is subject to unauthorized access (i.e. parking garage, service corridor, storage room, etc.), provide tamper-proof enclosure by drive manufacturer or provide secondary lockable fan-vented enclosure to prevent unauthorized access. Secondary enclosure shall be approved by variable frequency drive manufacturer.
- 5. AC line fused disconnect or circuit breaker.
- 6. Metal oxide varistors on incoming line for transient protection.
- 7. Control power transformer with fused primary and 24V or 120V fused secondary.
- 8. Manual, speed adjustment potentiometer of keypad, HAND-OFF-AUTO switch, and 4-20 milliamp signal follower, fully isolated and suitable for grounded or ungrounded input signal. Drive manufacturer shall coordinate exact signal type with temperature control contractor.
- 9. Instantaneous overcurrent shutdown with indicator light when current exceeds 200%. Time-overcurrent overload protection for the motor.

10. Inverse characteristic time-overcurrent overload protection for the motor sized in accordance with NEC requirements.
11. Drive shall be capable of withstanding random application of an output short circuit without damage to drive components or fuses.
12. Input phase loss and undervoltage protection.
13. Torque/current limit control which will slow the motor without tripping when the motor is subjected to an overload, or slow the acceleration ramp when accelerating a high inertia load.
14. Drives shall be capable of “riding through” a momentary loss of power for up to 2 seconds.
15. AC line reactors in the drive cabinet for protection against line notching and surges without requirement for an input isolation transformer.
16. Power factor shall be minimum 95% at all speeds and loads.
17. Each drive shall have the following status and troubleshooting diagnostic features:
 - a. Auto restart in “auto” mode. Certain drive faults shall be selectable to bypass the auto restart feature. Auto restart manual shall only be attempted 5 times.
 - b. Exterior drive door mounted devices shall include”
 - 1) “Power On” pilot light.
 - 2) “VFD Run” pilot light.
 - 3) % full load digital display.
 - 4) Output frequency and/or % speed digital meter.
 - c. Indicator lights on each power module to indicate correct operation (or failure) of individual owner switching devices.
 - d. DRIVE/OFF/LINE test switch.
18. UL listed or ETL listed.
19. Minimum and maximum speed adjustment.
20. Factory Tests: The VFD shall be tested with the system logic and given complete factory tests including simulated operation.
 - a. Provide certification this test has been made for the particular units shipped for this job.
21. Field Adjustments: Independent acceleration/deceleration rates: 0.5 – 120 seconds.
22. Provide a maximum of 1000-Volts at the motor terminals.
23. Provide LAN card connection to interface with Building Automation System. Coordinate control protocols with BMS contractor.
24. Where the VFD is used as part of a smoke control or pressurization systems:
 - a. Provide a minimum of (6) six auxiliary contact(s) for connection to smoke control system.
 - b. VFD to be UUKL864 listed for smoke management.
 - c. Provide torque indication output on drive to verify airflow.
 - d. VFD shall not be equipped with bypass.

- E. In addition to the above feature all drives shall have the following additional features:
1. Catch-a-spinning load capability.
 2. Critical speed avoidance capability.
 3. Where the building walls are not suitable for mounting drives a floor stand kit shall be provided.
 4. Where required by Division 23 09 01, provide output isolator to provide VFD signal operation of frequency, and current to an isolated 4-20 mA signal for transmission to the building automation system for monitoring capability.
- F. For variable frequency drives serving multiple motors, the following shall be provided:
1. Provide motor contactors for each motor for drives serving more than one motor, each contactor shall have auxiliary contacts to prevent drive damage if remote motor disconnect switch is open or closed.
 2. Each drive shall have contactors for each motor it serves with individual thermal overload protection for each motor and H-O-A motor select switch.
 3. All multiple motor variable speed controllers shall be capable of operating even if one of the motors is off.
- G. For drive manufacturers who use portable test meter for diagnostics, provide not less than one test meter for each model or type used. Meters shall be supplied to the Owner upon completion of the project.
- H. Provide one complete set of spare fuses for all variable speed controllers.
- I. Interlock all disconnects with variable speed drive so variable speed drive opens before disconnect opens to prevent damage to the drive.

PART 3 - EXECUTION

3.1 GENERAL

- A. Deliver units to installer of electrical work. Provide installation and wiring instruction and diagrams.
- B. Provide wiring control diagrams and instructions to installer of automatic temperature controls.
- C. Provide factory representative at start-up to check installation and instruct Owner.

END OF SECTION 23 05 30

SECTION 23 05 48 - VIBRATION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplemental Conditions of the Construction Contract, and Division 1 Specification Sections (General Requirements), apply to this Section.

1.2 DESCRIPTION

- A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the drawings and as specified herein to provide complete vibration isolation systems in proper working order.

1.3 MATERIAL AND EQUIPMENT

- A. Design Basis: Mason Industries
- B. Alternate Manufacturers:
 - 1. Amber/Booth Co.
 - 2. California Dynamics
 - 3. Kinetics
 - 4. Korfund Dynamics Corp.
 - 5. Vibration Eliminator Co.
 - 6. Vibration Mountings & Controls, Inc.
 - 7. Vibro-Acoustics
- C. Unless otherwise specified, supply only new equipment, parts and materials.

1.4 QUALITY ASSURANCE

- A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- B. Provide vibration isolators of the appropriate sizes, with the proper loading to meet the specified deflection requirements.
- C. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim or additional payment.

- D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
- E. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

1.5 SUBMITTALS

- A. Reference Division 1.
- B. Prior to ordering any products, submit shop drawings or the items listed below. The shop drawings must be complete when submitted and must be presented in a clear, easily understood form. Incomplete or unclear presentation of shop drawings may be reason for rejection of the submittal.
 - 1. A complete description of products to be supplied, including product data, dimensions, specifications, and installation instructions.
 - 2. Detailed selection data for each vibration isolator supporting equipment, including:
 - a. The equipment identification mark;
 - b. A cut sheet of the isolated equipment showing equipment support points and operating weight at each point.
 - c. The isolator type;
 - d. The actual load;
 - e. The static deflection expected under the actual load;
 - f. Specified minimum static deflection;
 - g. The additional deflection-to-solid under load;
 - h. The ratio of spring height under load to spring diameter.
 - 3. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
 - 4. Special details necessary to convey complete understanding of the work to be performed.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION MOUNT TYPES

A. General:

1. All metal parts of vibration isolation units installed out-of-doors shall be cold-dip galvanized, cadmium plated, or neoprene coated after fabrication. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard No. 14.
2. All isolators installed out-of-doors shall have base plates with bolt holes for fastening the isolators to the support members.
3. Isolator types are scheduled to establish minimum standards. At the Contractor's option, laborsaving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories must not degrade the vibration isolation system.
4. Static deflection of isolators shall be as provided in SECTION 3 - EXECUTION. All static deflections stated are the minimum acceptable deflection for the mounts under actual load. Isolators selected solely on the basis of rated deflections are not acceptable and will be disapproved.

B. Type FSN (Floor Spring and Neoprene)

1. Spring isolators shall be freestanding and laterally stable without any housing. Spring diameter shall be not less than 0.8 of the compressed height of the spring at the rated load. Springs shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately one (1). All mounts shall have leveling bolts.
2. Either the spring element in the isolator shall be set in a neoprene cup and have a steel washer to distribute the load evenly over the neoprene, or each isolator shall be mounted on a Type NP isolator. If the NP isolator is used, provide a rectangular bearing plate of appropriate size to load the pad uniformly within the manufacturer's recommended range.
3. If the basic spring isolator has a neoprene friction pad on its base and a NP isolator is to be added to the base, a galvanized steel, stainless steel or aluminum plate shall be used between the friction pad and the NP isolator. If the isolator is outdoors, the plate shall not be made of galvanized steel. The NP isolator, separator plate and friction pad shall be permanently adhered to one another and to the bottom of the bearing plate.
4. If the isolator is to be fastened to the building structure and Type NP isolator is used under the bearing plate, neoprene grommets shall be provided for each bolt hole in the base plate. Bolt holes shall be properly sized to allow for grommets. The hold down bolt assembly shall include washers to distribute load evenly over the grommets. Bolts and washers are to be galvanized.

Type FSN isolators shall be Mason Type SLF with the appropriate neoprene pad (if used) selected from Type NP or approved equal.

C. Type FSNTL (Floor Spring and Neoprene Travel Limited)

1. Spring isolators shall be freestanding and laterally stable without any housing. Spring diameter shall not be less than 0.8 of the compressed height of the spring at the rate load. Spring shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately one (1). All mounts shall have leveling bolts. All mounts shall have vertical travel limit stops to control extension when weight is removed. The travel limit stops shall be capable of serving as blocking during erection of the equipment. A minimum clearance of 1/4" shall be maintained around restraining bolts and between the limit stops and the spring to avoid interference with the spring action.
2. Either the spring element in the isolator shall be set in a neoprene cup and have a steel washer to distribute the load evenly over the neoprene, or each isolator shall be mounted on a Type NP isolator. If the NP isolator is used, provide a rectangular bearing plate of appropriate size to load the pad uniformly within the manufacturer's recommended range. If the basic spring isolator has a neoprene friction pad on its base and a NP isolator is to be added to the base, a galvanized steel, stainless steel or aluminum plate shall be used between the friction pad and the NP isolator. If the isolator is outdoors, the plate shall not be made of galvanized steel. The NP isolator, separator plate, and friction pad shall be permanently adhered to one another and to the bottom of the bearing plate.
3. If the isolator is to be fastened to the building structure and Type NP isolator is used under the bearing plate, neoprene grommets shall be provided for each bolt hole in the base plate. Bolt holes shall be properly sized to allow for grommets. Hold down assembly shall include washers to distribute load evenly over the grommets. Bolts and washers are to be galvanized.

Type FSNTL isolators shall be Mason Type SLR with the appropriate neoprene pad (if used) selected from Type NP or approved equal.

D. Type FN (Floor Neoprene)

1. Neoprene isolators shall be neoprene-in-shear type with steel reinforced top and base. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed. Bolt holes shall be provided in the base and the top shall have a threaded fastener. The mounts shall include leveling bolts that may be rigidly connected to the equipment.

Type FN isolators shall be Mason Type ND or approved equal.

E. Type FNC (Floor Neoprene Chiller)

1. Neoprene isolators shall be double neoprene-in-shear type with steel reinforced top intermediate plates and base. Neoprene elements shall be 3/4". Steel plates shall be 1/4" and the top and bottom plates shall be ribbed. Bolt holes shall be provided in the base and the

top shall have a threaded fastener. The mounts shall include leveling bolts that may be rigidly connected to the equipment.

Type FNC isolators shall be Mason Type ND: Fabricate of type “Super W” pads, similar to Type ND otherwise.

F. Type NP (Neoprene Pad)

1. Neoprene pad isolators shall be one layer of ¼” to 3/8” thick ribbed or waffled neoprene. The pads shall be sized so that they will be loaded within the manufacturer’s recommended range.

Type NP isolators shall be Mason Type W or approved equal.

G. Type DNP (Double Neoprene Pad)

1. Neoprene pad isolators shall be formed by two layers of ¼” to 3/8” thick ribbed or waffled neoprene, separated by a galvanized steel, stainless steel or aluminum plate. If the isolator is outdoors, the plate shall not be made of galvanized steel. These layers shall be permanently adhered together. The pads shall be sized so that they will be loaded within the manufacturer’s recommended range.

Type DNP isolators shall be Mason Type WSW or approved equal.

H. Type HSN (Hanger Spring and Neoprene)

1. Vibration isolation hangers shall consist of a free standing and laterally stable steel spring and a neoprene element in series, contained within a steel housing. Spring diameters and hanger housing lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the housing. Hangers shall provide a means to adjust hanger elevation under load. Spring diameter shall be not less than 0.8 of the compressed height of the spring at the rated load. Spring elements shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. The neoprene element shall be designed to have a 0.3” minimum static deflection. The deflection of both the spring element and the neoprene element shall be included in determining the overall deflection of Type HSN isolators.

Type HSN isolators shall be Mason Type P30N or approved equal.

I. Type HN (Hanger Neoprene)

1. Vibration isolation hangers shall consist of a neoprene-in-shear element contained within a steel housing. A neoprene neck bushing shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. The

diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30° arc before contacting the hanger housing.

Type HN isolators shall be Mason Type HD or approved equal.

2.2 EQUIPMENT BASES

A. Type BIB (Base - Inertia Base)

1. Concrete inertia bases shall be formed of stone-aggregate concrete (150 lbs./cu.ft.) and appropriate steel reinforcing cast between welded or bolted perimeter structural steel channels. Inertia bases shall be built to form a rigid base which will not twist, deform, deflect, or crack in any manner which would negatively affect the operation of the supported equipment or the vibration isolation mounts. Inertia bases shall be adequately sized to support basic equipment units and motors plus any associated pipe elbow supports, duct elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. Inertia base depth shall be at least 1/12 the longest dimension of the inertia base, but not less than 6" nor more than 12". The base footprint shall be large enough to provide stability for supported equipment. Inertia bases shall include side-mounting brackets for attachment to vibration isolators. Mounting brackets shall be located on the sides of the base that are parallel to the axis of rotation of the supported equipment.
2. The steel frame and reinforcement shall be supplied by the vibration isolator manufacturer. Concrete may be provided by the General Contractors. Frame and reinforcement for Type BIB bases shall be Mason Type KSL or approved equal.

B. Type BC-1 (Base - Curb)

1. Curb type isolation bases shall be a prefabricated assembly consisting of an extruded aluminum frame and steel spring isolation system that fits over the roof curb and under the isolated equipment. The aluminum frame shall be sufficiently rigid to support the equipment load without detrimental twist or deflection. Spring isolators shall be selected and positioned along the curb to achieve the minimum static deflection called for in the schedule. The static deflection shall be constant around the entire periphery of the base. Springs shall be free standing, laterally stable with a diameter of not less than 0.8 times the compressed height, and have additional travel-to-solid that is at least 50% of the rated deflection. Resilient neoprene snubbers shall be provided at the corners of the base to limit the movement of the equipment under wind load to 1/4".
2. The isolation curb base shall be made weather tight by sealing all around the periphery with closed cell neoprene or flexible vinyl. This shall in no way inhibit the vibration isolation of the spring elements. A closed cell sponge gasket or field caulking shall be used between the equipment unit and the isolation curb base and between the isolation curb and roof curb to form a weather-tight seal.

3. Each spring isolator used in the curbs shall be weather protected as described above.

Type BC-1 vibration isolation curb bases shall be Mason Type CMAB or approved equal.

2.3 RESILIENT LATERAL GUIDES

- A. These units shall either be a standard product of the vibration isolation mounting manufacturer, or be custom fabricated from standard components. These units shall incorporate neoprene isolation elements similar to Type FN which are specifically designed to provide resilient lateral bracing of duct or pipe risers.

Resilient lateral guides shall be Mason Type ADA.

2.4 FLEXIBLE DUCT CONNECTORS

- A. Refer to section 23 33 00 Ductwork Accessories for flexible duct connector specifications.
- B. The clear space between connected parts shall be a minimum of 3" and the connection shall have 5" minimum of slack material.

2.5 FLEXIBLE PIPE CONNECTIONS

- A. Flexible pipe connection shall be fabricated of multiple plies of nylon cord, fabric, and neoprene; and shall be vulcanized so as to become inseparable and homogeneous. Flexible connections shall be formed in a double sphere shape, and shall be able to accept compressive, elongative, transverse, and angular movements.
- B. The flexible connections shall be selected and specially fitted, if necessary, to suite the system temperature, pressure, and fluid type. In addition, suitable flexible connections should be selected which do not require rods or cables to control extension of the connector.
- C. Connectors for pipe sizes 2" or smaller shall have threaded female union couplings on each end. Larger sizes shall be fitted with metallic flange couplings.
- D. Flexible pipe connections shall be Mason Industries Type SFDEJ; Metraflex DoubleSphere; or Amber/Booth Type 2600 or 2655.

2.6 RESTRAINTS

- A. Snubber:
 1. Snubbers shall be custom fabricated using Type FN isolators mounted to steel angle brackets. The steel angle shall be sufficiently rigid and the mounting sufficiently secure to resist excessive movement of equipment during on-off cycle.

B. Thrust Restraints:

1. Thrust restraints shall consist of a spring element in series with a neoprene pad. The unit shall be designed to have the same deflection due to thrust-generated loads as specified for the isolators supporting the equipment. The spring element shall be contained within a steel frame and be designed so it can be precompressed at the factory to allow for a maximum of ¼" movement during starting or stopping of the equipment. Allowable movement shall be field-adjustable.
2. The assembly shall be furnished complete with rods and angle brackets for attachment to both the equipment and the adjacent fixed structural anchor.
3. Thrust restraints shall be Mason Industries Type WB, Kinetics Noise Control Type HSR, Amber/Booth Type TRK or an equal product of the manufacturer supplying the isolators.

2.7 GROMMETS

- A. Grommets shall either be custom made by combining a neoprene washer and sleeve, be Isogrommets as manufactured by MBIS, Inc. (Bedford Heights, Ohio), or be Series W by Barry Controls (Watertown, Mass.). Grommets shall be sized so that they will be loaded within the manufacturer's recommended load range. Grommets shall be specially formed to prevent both from directly contacting the isolator base plate.

2.8 ACOUSTICAL SEALANT

- A. Sealants for acoustical purposes as described in this specification shall be silicone or one of the non-setting sealants indicated below:

Acoustical Sealant	D.A.P
BR-96	Pecora
Acoustical Sealant	Tremco
Acoustical Sealant	U.S.G.

PART 3 - EXECUTION

3.1 APPLICATION

- A. General:
1. Refer to SECTION 2 - PRODUCTS of this specification for vibration isolation devices identified on the drawings or specified herein.
 2. The static deflection values of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected solely on the basis of rated deflection are not acceptable and will be disapproved.

B. Major Equipment:

1. Unless otherwise shown or specified, all floor-mounted major equipment shall be set on 4" high concrete housekeeping pads. See architectural or structural drawings for details.
2. Types and minimum static deflections of vibration isolation devices for major equipment items shall be as scheduled on the drawings or specified hereunder.
3. Flexible duct connectors shall be installed at all fan unit intakes, fan unit discharges, and wherever else shown on the drawings unless noted otherwise. Individual fan units with motors rated at less than $\frac{3}{4}$ hp do not require a flexible connector. Do not install flexible duct connectors in grease exhaust systems.
4. Flexible pipe connections shall be installed at all pipe connections to vibration-isolated equipment in the positions shown on the drawings.
5. Thrust restraints shall be installed on all floor-mounted fans developing 4" or more of static pressure, all suspended fans developing 2" or more static pressure, and wherever else called for on the drawings.
6. Snubbers shall be installed as called for on the drawings.

C. Miscellaneous Mechanical Equipment:

1. Miscellaneous pieces of mechanical equipment such as converters, pressure reducing stations, dryers, strainers, storage tanks, condensate receiver tanks, and expansion tanks which are connected to isolated piping system shall be vibration isolated from the building structure by Type NP or Type HN isolators (selected for 0.1" static deflection) unless their position in the piping system requires a higher degree of isolation as called for under Pipe Isolation.

D. Pipes:

1. All chilled water, condenser water, heating water, drain and engine exhaust piping that is connected to vibration-isolated equipment shall be isolated from the building structure within the following limits:
 - a. Within mechanical rooms.
 - b. And within 50' total pipe length of connected vibration-isolation equipment (chillers, pumps, air handling units, pressure reducing stations, etc.):
2. Piping shall be isolated from the building structure by means of vibration isolation mounts, resilient pipe guides, and resilient penetration sleeve/seals.
3. Isolators for the first three support points adjacent to connected equipment shall achieve one half the specified static deflection of the isolators supporting the connected equipment. When the required static deflection of these isolators is greater than $\frac{1}{2}$ " Type FSN or HSN isolators shall be used. When the required static deflection is less than or equal to $\frac{1}{2}$ ", Type FN or HN isolators shall be used. All other pipe support isolators within the specified limits shall be either Type FN or HN achieving at least $\frac{1}{4}$ " static deflection.
4. Where lateral support of pipe risers is required within the specified limits, this shall be accomplished by use of resilient lateral supports.

5. Pipes within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.
6. Provide flexible pipe connections on all piping connected to all isolated equipment and wherever shown on the drawings.

3.2 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT

A. General:

1. Locations of all vibration isolation devices shall be selected for ease of inspection and adjustment as well as for proper operation.
2. Installation of vibration isolation equipment shall be in accordance with the manufacturer's instructions.

B. Isolation Mounts:

1. All vibration isolators shall be aligned squarely above or below mounting points of the supported equipment.
2. Isolators for equipment with bases shall be located on the sides of the bases, which are parallel to equipment shaft unless this is not possible because of physical constraints.
3. Locate isolators to provide stable support for equipment, without excess rocking. Consideration shall be given to the location of the center of gravity of the system and the location and spacing of the isolators. If necessary, a base with suitable footprint shall be provided to maintain stability of supported equipment, whether or not such a base is specifically called to herein.
4. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plates shall rest entirely on the pad.
5. Hanger rods for vibration-isolated support shall be connected to structural beams or joists, not the floor slab between beam joists. Provide suitable intermediate support members as necessary.
6. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360° about the rod axis without contacting any object.
7. Parallel running pipes may be hung together on a trapeze, which is isolated from the building. Isolator deflections must be the greatest required by the provisions for pipe isolation for any single pipe on the trapeze. Do not mix isolated and non-isolated pipes on the same trapeze.
8. Pipes, ducts and equipment shall not be supported from other pipes, ducts and equipment.
9. Resiliently isolated pipes, ducts and equipment shall not come in rigid contact with the building construction or rigidly supported equipment.
10. The installed and operating heights of equipment vibration-isolated with Type FSNTL isolators shall be identical. Limit stops shall be out of contact during normal operation. Adjust isolators to provide 1/4" clearance between the limit stop brackets and the isolator top plate, and between the travel limit nuts and travel limit brackets.
11. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

C. Bases:

1. No equipment unit shall bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators and such direct support is approved by the equipment manufacturer. This provision shall apply whether or not a base frame is called for on the schedule. In the case that a base frame is required for the unit because of the equipment manufacturer's requirements and is not specifically called for on the equipment schedule, a base frame recommended by the equipment manufacturer shall be provided at no additional expense.
2. Unless otherwise indicated, there is to be a minimum operating clearance of 1" between inertia bases or steel frame bases and the floor beneath the equipment. Position isolator mounting brackets and adjust isolators so that the required clearance is maintained. The clearance space shall be checked by the Contractor to ensure that no construction debris has been left to short circuit or restrict the proper operation of the vibration isolation system.

D. Flexible Duct Connections:

1. Sheet metal ducts and plenum opening shall be squarely aligned with the fan discharge, fan intake, or adjacent duct section prior to installation of the flexible connection, so the clear length is approximately equal all the way around the perimeter. Flexible duct connections shall not be installed until this provision is met. There shall be no metal-to-metal contact between connected sections, and the fabric shall not be stretched taut.

E. Flexible Pipe Connections:

1. Install flexible pipe connections in strict accordance with the manufacturer's instructions.

F. Restraints:

1. Snubbers shall be adjusted to clear the equipment base and to provide lateral restraint during on-off cycling, but be out of contact during normal operation of the equipment.
2. Thrust restraints shall be attached at the centerline of thrust and symmetrically on each side of the unit. The two rods of the thrust restraint shall be axially aligned. This may require modified brackets or standoffs. The body of the thrust restraint shall not come in contact with the connected elements. Thrust restraints shall be adjusted to constrain equipment movement to the specified limit.

G. Resilient Penetration Sleeve/Seals:

1. Maintain an airtight seal around the penetrating element and prevent rigid contact between the penetrating element and the building structure. Fit the sleeve tightly to the building construction and seal airtight on both sides of the construction penetrated with acoustical sealant.
 - a. At minimum, provide resilient penetration seals at all Mechanical, Equipment and Fan Room Penetrations.

3.3 ISOLATOR SCHEDULE

UNIT	ISOLATOR TYPE	MINIMUM STATIC DEFL.(IN.)	REMARKS
Energy Recovery Ventilators			Internally isolated
Air Cooled Chiller	FSNTL	2	
Inline Fans	HSN	2	
Fan Coil Units	(Note 2)	(Note 2)	
Ceiling-suspended Inline Pumps	HSN	0.75	
Floor-supported Inline Pumps	FN	0.35	
Pumps (Basemount)	BIB (Note 3)	1.5	
Ice Plant Outdoor Condenser	FSNTL	2	
Boiler	FN	0.35	
Utility Set Fans	FSNTL	2	
Makeup Air Units			Internally isolated

Notes:

1. External isolator may be omitted if units have internally isolated fans and no other rotating or reciprocating components.
2. Isolators for fan coil units should be either HSN with 0.75" minimum static deflection or be equivalent to Mason Industries Type HN with 0.35" minimum static deflection.
3. For slab-on-grade installations isolators are not required. Refer to Section 23 21 23.

END OF SECTION 23 05 48

SECTION 23 05 49 - SEISMIC RESTRAINTS

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. Routt County is currently identified as a Seismic Category C. Provide seismic bracing/support for applicable building(s) with an importance factor above 1.0 as defined by the IBC. Detailed selection data for seismic restraints for buildings including:
 - 1. Submit manufacturer's data for all manufactured restraints.
 - 2. All submittals shall be stamped and certified by a Structural Engineer registered in the State of Colorado with a minimum of 5 years experience in the design of seismic restraints.
 - 3. Submit shop drawings for all fabricated restraints.
 - 4. Show restraint type and location on the installation shop drawings. Drawings to include:
 - a. All seismic brace locations.
 - b. All seismic restraint connections to structure and vertical support anchorage at seismic locations and all other vertical support anchorage connections. Including but not limited to Quantity, Size, and Embedment.
 - c. Brace reaction at all connection points to the structure for Structural Engineer of Record use in checking suitability of the building structure.
 - d. Type and size of brace member.
 - e. Suspended utility maximum lbs. per linear foot or maximum conduit size at all seismic locations.
 - f. Minimum all thread rod size at all seismic locations.
 - g. Size all horizontal support members taking into account, but not limited to, deflection and load.
 - h. Registered Colorado Engineer stamp and signature.
 - 5. Submit calculations for all seismic restraint systems that are not preapproved.
 - 6. Job site conditions not covered by the manufacturer's seismic bracing guidelines shall be engineered by the manufacturer.
- B. Provide complete seismic anchorage and bracing for mechanical equipment, including air terminal units and sound traps, to resist seismic forces acting in any direction using the criteria

outlined in ASCE 7-10, Chapter 13. Refer to ASCE 7-10, Table 13.6-1 for application values and horizontal force factors “Ap” and Rp.” Consider the effect of temperature change in preparation of anchorage and bracing details. Provide anchorage calculations and details certified by structural engineer registered in the State of Colorado. Where anchorage details are not shown on the drawings, the field installation shall be subject to the approval of the structural engineer of record prior to installation.

- C. At seismic restraint installation locations, provide vertical supports and attachments engineered to accommodate dead load plus seismic force reactions.
- D. Provide engineered seismic restraint systems compliant with the International Building Code for ductwork and piping. Location of seismic restraints shall be based on Contractor’s coordinated shop drawings.
- E. Provide seismic joints/loops for piping crossing building seismic separations.

1.3 RELATED APPLICABLE SECTIONS

- A. Section 23 05 02, BASIC HVAC REQUIREMENTS.
- B. Section 23 05 03, BASIC HVAC MATERIALS AND METHODS.
- C. Section 23 05 48, VIBRATION CONTROL.

1.4 REFERENCES

- A. Publications, codes and standards listed below form a part of this specification to the extent referenced.
 - 1. 2018 International Building Code
 - 2. ASCE 7-10, Chapter 13, Minimum Design Loads For Buildings and Other Structures, American Society of Civil Engineers (ASCE).
 - 3. ACI 318, Building Code Requirements for Structural Concrete, American Concrete Institute (ACI).

1.5 COMPONENT IMPORTANCE FACTOR

- A. Refer to project structural drawings for required building importance factor.

1.6 SUBMITTALS

- A. Submitted systems shall be per Mason Industries, ISAT, or B-Line/Tolco. Contractor shall identify and convey each deck condition to which seismic attachments will be made.

Information shall include type and size of steel member and any point load limitations or restrictions.

- B. All post installed anchors shall be ICC approved and seismically qualified in cracked concrete as reflected in the anchor manufacturers ICC report.
 - 1. DEWALT Power-Stud+ SD2
 - 2. Hilti KB-TZ
 - 3. Approved Equal
- C. All cast in place anchors shall be ICC approved and seismically qualified in cracked concrete as reflected in the anchor manufacturers ICC report. If the product accepts multiple rod sizes, the ICC report must verify the shear load for the rod size chosen.
 - 1. DEWALT Bang-It+, Wood-Knocker II+, DDI+
 - 2. Simpson Blue Banger
 - 3. Approved Equal
- D. Provide Seismic Design Force calculations per ASCE 7-10, Formula 13.3-1 stamped by a civil or structural engineer licensed to practice in the State of Colorado. Calculations shall utilize correct Seismic Coefficients per ASCE 7-10, Table 13.6-1 for the component and installation condition.
- E. Per ASCE 7, the results of Formula 13.3-1 need not be greater than Formula 13.3-2 and may not be less than Formula 13.3-1.
- F. Submit seismic restraint layouts stamped by a civil or structural engineer licensed to practice in the State of Colorado. Seismic restraint layouts to show:
 - 1. All vertical support and seismic brace locations.
 - 2. All anchorage connections to structure. Anchor brand, type, quantity and size.
 - 3. Vertical support and brace reaction point load at all connections to structure. For review by engineer of record in checking suitability of the building structure to accommodate imposed loads.
 - 4. Plan set sheets showing appropriate installation details reflecting actual job site conditions.
- G. Include cover sheet with Seismic Restraint Bracing Legend delineating:
 - 1. Maximum Allowable Size or Utility Weight (Lbs/Lf).
 - 2. Minimum Vertical Support Rod Diameter.
 - 3. Support Rod Total Vertical Load.
 - 4. Maximum Allowable Transverse Brace Spacing.
 - 5. Transverse Brace Reaction.
 - 6. Maximum Allowable Longitudinal Brace Spacing.
 - 7. Longitudinal Brace Reaction.
 - 8. Minimum Required Seismic Restraint Brace Arm Assembly.

9. Minimum Required Seismic Restraint Anchorage To Overhead Structure.
10. Installation Detail Drawing References.

1.7 QUALITY ASSURANCE

- A. Project structural engineer of record to check suitability of structure to accommodate applied seismic loads.
- B. The representative of the seismic restraint system manufacturer (the Seismic Vendor) shall walk the job site and provide documentation indicating conformance to the approved project shop drawing seismic restraint layout.
- C. Contractor responsible for the construction of a “designated Seismic System” or a seismic resisting component listed in the “Statement of Special Inspections” shall submit to the Building Official and Owner’s Representative prior to the commencement of work, on the system or component, a written “statement of Responsibility” per CBC Section 1706A. Consult the Seismic Vendor for assistance in meeting this requirement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Seismic restraint hardware and engineering shall be furnished by Mason Industries, or equivalent by International Seismic Application Technology, B-Line/Tolco. Referred to in this specification section as the Seismic Vendor.

2.2 SEISMIC SWAY BRACES

- A. Seismic sway braces shall consist of galvanized steel aircraft cables, steel angles or steel struts.
- B. Cable braces shall be designed to resist seismic tension loads and steel braces shall be designed to resist both tension and compression loads. Brace end connections shall be steel assemblies that swivel to the final installation angle.
- C. Cable brace assemblies shall have published strength and stiffness ratings based on testing per FM-1950 standards.
- D. Angle or strut bracket assemblies shall be FM Approved, except as noted below.
- E. Steel angles or struts, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps.

- F. Cable brace bracket assemblies shall be Type SCB or SCBH. Solid brace bracket assemblies shall be Type SSB-FM, SSBS-FM or SHB-FM. All bracket assemblies shall have published strength and stiffness values based on testing per FM-1950.
- G. Rod clamps shall be type SRC or UCC.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Vertical support and seismic restraint anchorages shall be per IBC and the Seismic Vendor's applications, design and inspection manual.
- B. For conditions not covered within the Seismic Vendor's applications, design and inspection manual, the required engineering shall be performed by the Seismic Vendor.
- C. The Seismic Vendor shall provide field installation training prior to commencement of install.
- D. Field relocation of any seismic installation points away from that shown on the Seismic Vendor furnished shop drawing layouts shall be coordinated with the Seismic Vendor's Technical Service.
- E. Consult the Seismic Vendor's Technical Service when field conditions prohibit compliance with the supplied installation details.
- F. The allowable brace spacing for piping systems shall be as determined by analysis per ASCE 7-10 Section 13.6.8 or ASME B31E.
- G. Any utilities crossing building seismic separations shall be provided with seismic joints/loops. Provide seismic restraints at both sides of the separation.

3.2 EQUIPMENT CONNECTIONS

- A. Where seismic bracing is allowed by code to be omitted due to component size or proximity to overhead deck, all terminations to fixed equipment, coils, etc. or to other portions of the system requiring seismic restraint shall utilize flexible connectors.

3.3 INSPECTION

- A. Where seismic bracing is allowed by code to be omitted due to size or proximity to overhead deck, the inspector of record and contractor shall be responsible for assuring that damaging impact or vertical support failure cannot occur.

3.4 SPECIAL INSPECTION

- A. Seismic Restrain Special Inspection Requirements: All designated seismic systems and all seismic resisting components listed in the “statement of special inspections” are subject to Special Inspection. The Seismic Vendor shall provide a special inspection plan to the contractor for submittal to the Owner’s Representative and design team for use by the project’s special inspectors. The plan shall include the following:
1. A list of all components of the seismic system that require inspection or testing.
 2. The required frequency of testing and inspection.
 3. Type and nature of testing required.
- B. Special inspection for mechanical components shall be provided as follows:
1. Periodic special inspection during the installation for flammable, combustible or highly toxic piping systems and their associated mechanical units in Seismic Design Categories C, D, E, or F.
 2. Periodic special inspection during the installation of HVAC ductwork that will contain hazardous materials in Seismic Design Categories C, D, E, or F.
 3. Periodic special inspection during the installation of vibration isolation systems where the construction documents indicate a maximum clearance (air gap) between the equipment support frame and restraint less than or equal to 1/4”.
- C. In compliance with each anchor manufacturer’s ICC Report, post installed anchors shall be specially inspected.
- D. Upon completion of construction, a Quality Assurance Representative of the Seismic Vendor shall review the installation of the seismic force resisting system and provide documentation indicating general conformance to seismic restraint layout drawing.

END OF SECTION 23 05 49

SECTION 23 05 53 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Submit manufacturer's product data on the following:
 - 1. Plastic Pipe Markers and method of application.
 - 2. Engraved Plastic Laminate Sign.
- B. LEED:
 - 1. Adhesives and Sealants:
 - a. Submit product data or other published information verifying the VOC (Volatile Organic Compound) content is less than or equal to the allowable VOC content established by the governing standard: South Coast Air Quality Management District (SCAQMD) Rule #1168, July 1, 2005 and Green Seal Standard for Commercial Adhesives GS-36, October 19, 2000.
 - 2. Low-Emitting Paints and Coatings:
 - a. Submit product data or other published information verifying the VOC (Volatile Organic Compound) content is less than or equal to the allowable VOC content established by the governing standards: Green Seal Standard GS-11, Paints, First Edition, May 20, 1993; Green Seal Standard GC-03, Anti-Corrosive Paints, Second Edition, January 7, 1997; South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, January 1, 2004.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Except as otherwise indicated, provide manufacturer's standard products.
- B. Where more than a single type is specified for an application, selection is Installer's option, but provide a single selection for each application.

2.2 PLASTIC PIPE MARKERS (TYPE A)

- A. Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, color-coded, plastic-sheet pipe markers, complying with ANSI A13.1.
- B. For Pipes Less Than Six Inches (including insulation if any): Provide full-band pipe markers, extending 360° around pipe at each location, fastened by one of the following methods:
 - 1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 - 2. Adhesive lap joint in pipe marker overlap.
 - 3. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than ¾" wide; full circle at both ends of pipe marker, tape lapped 1-½".
- C. For Pipes Six Inches and Larger (including insulation if any): Provide either full-band or strip-type markers, but not narrower than 3 x letter height, taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-½" wide; full circle at both ends of pipe marker, tape lapped 3".
- D. Lettering: Manufacturer's pre-printed wording which conforms to contract document system descriptions.
- E. Match existing terminology for systems which are modified by this work.
- F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering or as a separate unit of plastic (to accommodate both directions).

2.3 STENCILING (TYPE B)

- A. Using a color contrasting to the surface to identify, spray or brush paint through neatly cut stencils.
- B. Lettering shall conform to wording on contract documents. Size shall be in accordance with ANSI A13.1.

2.4 BACKGROUND COLOR AND STENCILING (TYPE C)

- A. In addition to the requirements above, paint a background color band in accordance with ANSI A13.1.

2.5 VALVES TAGS

- A. Brass Valve Tags: Provide manufacturer's standard 19 ga brass tag; approximately 1-1/2" round with 1/2" high, black-filled numbers and 3/16" top hole.
 - 1. Numbers shall be sequential in accordance with schedule below.
 - 2. Provide separate numbering for each legend sequence. Provide separate sequences for the following:
 - a. Gas (GAS)
 - b. Plumbing (PLBG)
 - c. Heating Water (HTG)
 - d. All other systems (No legend)
- B. Valve Tag Fasteners: Manufacturer's standard chain (wire link or beaded type), or S-hooks.

2.6 VALVE SCHEDULE

- A. Provide schedule for each piping system, as defined on the drawings, and below, typewritten and reproduced on 8-1/2" x 11" bond paper.
- B. Tabulate valve number, piping system, system legend (as shown on tag), location of valve (room or space), and variations for identification (if any).
- C. Provide piping schematic for each system as defined below in Part 3.
- D. In addition to mounted copies, furnish extra copies for maintenance manuals as specified.
- E. Valve Schedule Frames: For each page of the valve schedule, provide a glazed frame, with screws for removable mounting on masonry walls.

2.7 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, 1/16" thick, black with white core (letter color).
- B. Fastening:
 - 1. Screws
 - 2. Rivets
 - 3. Permanent Adhesive

C. Lettering and Graphics:

1. Coordinate names, abbreviations and other designations used in the mechanical identification work, with the corresponding designations shown, specified or scheduled in the construction documents.
2. In addition, for heating or cooling units and exhaust fans, identify area served.

PART 3 - EXECUTION

3.1 GENERAL

- A. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, install identification after completion of covering and painting.
- B. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 DUCTWORK IDENTIFICATION

- A. **General:** Identify air supply, return, exhaust, intake and relief ductwork with stenciled signs and arrows, showing ductwork service and direction of flow, in black or white, whichever provides most contrast with ductwork color.
- B. **Location:** In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50' spacing along exposed runs.
- C. **Access Doors:** Provide stenciled or plastic laminate type signs on each duct or equipment-mounted access door in ductwork and housings, indicating the purpose of the access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.

3.3 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers on piping of the following systems and include arrows to show normal direction of flow.
 1. Domestic water piping (hot, cold, tempered; 120° hot, 180° hot, hot water recirculating, etc.).
 2. Plumbing vent and sanitary (above grade) piping.
 3. Storm piping.
 4. Heating water piping (supply and return).
 5. Chilled water piping (supply and return).

6. Natural gas piping, (indicate pressures).
 7. Ice plant brine water (supply and return).
 8. Refrigerant piping (suction, liquid, hot gas bypass).
 9. Beverage CO₂ piping
 10. Fire protection.
 11. Any other piping system as indicated on the drawings, or as required to match existing.
 12. See Section ___ for identification of medical gas piping.
- B. Locate pipe markers and color bands, as follows, on all piping exposed to view, above an accessible ceiling, and in accessible maintenance spaces (including chases and near access panels). In spaces exposed to view in public areas, effort is to be made to coordinate exact locations with architect.
1. Near each valve and control device.
 2. Near each branch, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch, where there could be a question of flow pattern.
 3. Near locations where pipes pass through walls, floors, or ceilings, or enter non-accessible enclosures.
 4. Near major equipment items and other points of origination and termination.
 5. Spaced intermediately at maximum spacing of 50' along each piping run.
 6. Within 6' of access doors above otherwise non-accessible ceilings and chases.
- C. Type:
1. Normally exposed to view - Type A or C.
 2. Normally concealed from view - Type B.

3.4 VALVE IDENTIFICATION

- A. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory fabricated equipment units, plumbing fixtures faucets, hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
- B. Mount framed valve schedules with piping schematics where directed by Architect.
- C. Identify each valve tagged on as-built drawings.

3.5 MECHANICAL EQUIPMENT IDENTIFICATION

- A. Install an engraved plastic laminate sign on or near each scheduled item of mechanical equipment.

- B. Provide engraved plastic laminate nameplate on every new piece of equipment not already provided with one in accordance with Section 23 05 02 of the specifications.
- C. Identify area served, if applicable.

3.6 NON-POTABLE WATER IDENTIFICATION

- A. Provide an engraved plastic laminate sign.
 - 1. Legend: "Non-Potable Water".
 - 2. Location: At each outlet of piping downstream of backflow preventer, (e.g., Boiler Room hose bibb).

END OF SECTION 23 05 53

SECTION 23 05 93 - TEST-ADJUST-BALANCE

PART 1 - GENERAL

1.1 RESPONSIBILITY

- A. The Balancing Contractor shall be a sub-contractor, directly working for the General Contractor.
- B. The Balancing Contractor shall not be a sub-contractor of any other Division 21, 22 or 23 Contractor.

1.2 QUALITY ASSURANCE

- A. Qualification:
 - 1. Work shall be done by a firm certified by the National Environmental Balancing Bureau (NEBB), or the Associated Air Balance Council (AABC), or the firm shall have technicians certified by the "National Training Fund Sheet Metal & Air Conditioning Industry".
 - 2. The firm shall be an independent testing and balancing firm specializing in testing and balancing of environmental systems.
 - 3. The firm shall have an experience record of not less than five (5) years of experience in the TAB industry.
- B. Industry Standards: Comply with the following:
 - 1. HVAC Systems-Testing, Adjusting, Balancing published by Sheetmetal and Air Conditioning Contractors National Association, Inc. (SMACNA).
 - 2. Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems published by National Environmental Balancing Bureau. (NEBB).
 - 3. ASHRAE Systems Handbook. Testing, Adjusting and Balancing.
- C. Registration: Work shall be done under the supervision of a professional engineer registered in Colorado. Engineer shall be available for all meetings and interpretation of all materials in the report.
- D. Pre-qualification of TAB Contractor.
 - 1. The firm must have experience and qualifications satisfactory to the consulting mechanical engineer and must be accepted by him prior to bidding.
 - 2. Firms desiring approval to provide work under this section shall submit a booklet indicating procedures and data forms that they would use in the performance of the work.

3. Submittals shall be in accordance with Division 1.
4. Only firms which have been approved by the mechanical engineer prior to bid date may provide work under this section.

PART 2 - PRODUCTS

2.1 PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL

- A. Sequence work to commence after completion of system and start-up procedures and schedule completion of work before Substantial Completion of Project.
- B. Examine the installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable.
- C. Notify the Contractor in writing of conditions detrimental to the proper completion of the test-adjust-balance work.
 1. Do not proceed with the work until unsatisfactory conditions have been corrected.
 2. Provide Engineer/Architect with a copy of the notification.
- D. Adjust air flows and heating water systems to within 10% of values shown. Adjust chilled water systems to within 5% of values shown. If design flows cannot be obtained within specified limits the Balancing Contractor will perform the following (at the minimum):
 1. Measure and record major pressure drops in the system.
 2. Consult with the Engineer and Installer as required.
 3. Upon receiving written directions to proceed and after any corrections are performed, re-balance affected portion of system.
- E. Optimization: Work closely with the Section 23 09 00 contractor to optimize setpoints.
 1. Establish the minimum air static pressure or water differential pressure for variable or bypass flow system.
 2. Establish the position of minimum outside air dampers, damper/valve and sequencing relays.
- F. Calibration: Be responsible for calibration of flow measurement devices used as input to the temperature control system. All air systems flow measurement stations including VAV terminals shall be calibrated against a pitot tube traverse or air diffuser capture hood. Balancing

contractor shall assure accuracy of all flow measurement devices or shall report on their failure to be accurate.

- G. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in a manner recommended by the original Installer.
- H. Make all final readings for each system at the same time, and after all adjustments have been made.
- I. Mark equipment settings, including damper control positions, balancing cocks, circuit setters, valve indicators, fan speed control settings and similar controls and devices, to show final settings at completion of test-adjust-balance work.
 - 1. Mark with paint or other suitable permanent identification material.
- J. Check all new thermal overloads.
 - 1. Identify improperly protected equipment in report.

3.2 AIR SYSTEMS

- A. Scope: All air systems are to be balanced.
- B. Before any adjustments are made, check for:
 - 1. Dirty filters, coils, or air intakes
 - 2. Duct leakage
 - 3. Filter leakage
 - 4. Damper leakage, or blockage
 - 5. Equipment vibrations
 - 6. Correct damper operation
- C. Simulate a pressure drop across filters equal to that when 50% loaded with dust.
 - 1. Check fan motor amps with clean filters and simulated loaded filters, and report.
- D. Procedure:
 - 1. Measure and report the following for all supply, return, exhaust, and outside air systems:
 - a. Individual air inlets and outlets.
 - b. Pitot traverses of main supply, return, exhaust and outside air ducts.
 - c. Rotating valve or velocity grid traverse of coils or filters.
 - d. Plot operating point on fan curve. Include compensation for effects of altitude and inlet vanes.

2. Above measurements shall be made with system in normal, full load condition.
 - a. Systems with economizers shall be measured at minimum outside air and 100% outside air.
 - b. Systems with 100% outside air capability or evaporative cooling sections shall be measured at maximum outside air.
 - c. VAV systems shall be measured at the zone level at maximum air condition, and at the main at the system diversity condition.
3. Make main duct traverses or coil/filter traverses and report operation at all other operating conditions (as applicable).
 - a. Economizer operation
 - b. Unoccupied mode
 - c. Smoke evacuation mode
 - d. Pre-cool mode
 - e. Fail over mode
 - f. Two-speed fans
 - g. All VAV terminals driven to maximum position
4. Set fan speed such that under no condition will the motor exceed the service factor rating when operating in any of the above possible modes.
5. Measure fan motor amps in each of the above possible operating modes (clean filters).
- E. Adjust Air Systems to provided proper air pressure relationships as shown by relative air quantities or as indicated on the drawings.
- F. Adjust distribution system for uniform space temperatures free from objectionable drafts and noise.
 1. Division 233300 to provide orifice plates or dampers where required.
- G. Exchange sheaves and belts as required to adjust the rpm of all fans so they handle specified air quantity.
- H. Set minimum outside air quantities.

3.3 DOMESTIC WATER SYSTEM

- A. Scope: Balance all domestic hot water and hot water re-circulation systems.
- B. Before any adjustments are made:
 1. Check temperature control device operation (mixing valves, external temperature control devices, etc.).
 2. Check rotation of pumps.

3. Adjust pressure reducing valves.
 4. Verify proper operation of ASME pressure and temperature relief valves.
- C. Using flow meters, adjust the quantity of water circulated by each pump and the flow in each branch of the hot water re-circulation systems.

3.4 HYDRONIC SYSTEMS

- A. Scope: Balance all hydronic systems.
- B. Before any adjustments are made:
1. Check temperature control valve operation.
 2. Check pump rotation.
 3. Adjust pressure reducing valve.
 4. Remove any roughing strainer screens in systems.
- C. Using system flow meters, adjust the quantity of fluid handled by each pump and supplied to each coil, piece of radiation, heat exchanger, cross-over bridge, bypass, etc., to meet design requirements.
- D. Procedure:
1. Measure and report all hydronic and domestic water recirculation systems by all of the below means which are applicable.
 - a. System, pump, branch, or terminal flow measuring stations.
 - b. Terminal or heat exchanger pressure drop, compare to submittal data.
 - c. Plot operating point on pump curve. Include compensation for effects of temperature, viscosity and density.
 2. Above measurements to be made and reported at full heating/cooling load.
 - a. For 3-way valve terminals/heat exchangers set bypass flow to equal coil flow.
 - b. For primary/secondary systems, set crossover/bridle to have constant flow at all conditions.

3.5 DETAILED REQUIREMENTS

- A. Measure, adjust and report the following:
1. Energy Recovery Ventilator Systems:
 - a. Total supply air CFM, fan speed, inlet pressure, outlet pressure, amp draw.
 - b. Total exhaust air CFM, fan speed, inlet pressure, outlet pressure, amp draw.
 - c. Filter pressure drop.

- d. Energy recovery wheel RPM, inlet pressure, outlet pressure, and amp draw.
 - e. Coil airflow.
 - f. Coil entering and leaving air temperature.
 - g. Coil entering and leaving air pressure.
 - h. Coil water flow.
 - i. Coil entering and leaving water temperature.
 - j. Coil entering and leaving water pressure.
 - k. Duct temperature at duct mounted temperature sensor.
 - l. Duct static pressure at supply and exhaust duct mounted pressure sensors.
2. Ductwork Systems:
- a. Airflow at each inlet and outlet.
 - b. Airflow at supply, return, outside air, and exhaust mains to determine total airflow.
 - c. VAV box entering and leaving air temperature.
 - d. VAV box entering and leaving static pressure.
 - e. VAV box airflow at minimum position, maximum position, and heating position.
3. Fan Coil Unit Systems:
- a. Supply fan airflow, fan speed, total static pressure, and amp draw.
 - b. Coil entering and leaving air temperature.
 - c. Coil water flow.
 - d. Coil entering and leaving water temperature.
 - e. Coil entering and leaving water pressure.
 - f. kW draw on electric coils.
 - g. Space temperatures at thermostats or sensors.
4. Environmental Fans:
- a. Total fan CFM.
 - b. Fan speed.
 - c. Fan total static pressure.
5. Gas-fired Makeup Air Units:
- a. Air flow.
 - b. Entering and leaving air temperature.
 - c. Entering and leaving static pressure.
 - d. Gas pressure.
 - e. Combustion air fan operation.
 - f. Flue temperature.
 - g. Start/stop controls.

6. Coils:
 - a. Coil airflow.
 - b. Coil entering and leaving air temperature.
 - c. Coil entering and leaving air pressure.
 - d. Coil water flow.
 - e. Coil entering and leaving water temperature.
 - f. Coil entering and leaving water pressure.
7. Heat Exchangers:
 - a. Cooler fluid entering temperature, leaving temperature, and fluid flow.
 - b. Warmer fluid entering temperature, leaving temperature, and fluid flow.
8. Air-cooled Chiller:
 - a. Cooling water flow.
 - b. Cooling water temperature entering and leaving.
 - c. Cooling water pressure entering and leaving.
 - d. Evaporative-pre cooling system booster pump amp draw.
 - e. Compressor safety and operating controls.
 - f. Compressor amps and kW draw.
 - g. Capacity reduction controls.
 - h. Free cooling coil operation.
 - i. Refrigerant suction pressure.
 - j. Low ambient controls for packaged chiller systems.
9. Boilers:
 - a. Heating water temperature entering and leaving.
 - b. Heating water flow.
 - c. Heating water pressure entering and leaving.
 - d. Boiler safety and operating controls.
 - e. Capacity reduction controls.
 - f. Stack temperatures.
 - g. Gas pressure and cubic feet of gas per hour.
 - h. Combustion efficiency.
 - i. If boiler is equipped for variable firing rates, include data for a. through h. for maximum and minimum firing rates.
 - j. Manufacturer's start-up report may be substituted if all above measurements are included.
10. Pumps:
 - a. Water flow.
 - b. Entering and leaving water pressure.

- c. Motor amps and kW draw.
 - d. Installed impeller diameter.
- 11. Split system air conditioners and heat pumps:
 - a. Refrigerant suction pressure.
 - b. Fan operation.
 - c. Compressor operation.
 - d. Low ambient controls.
 - e. Automatic restart upon loss and regain of electrical power.
- 12. Controls:
 - a. Operational setting of controllers and instruments.
 - b. Positioning and function of valves and dampers.
 - c. Interlock and operation of systems (HVAC and Fire).
- 13. Cabinet Heaters and Unit Heaters:
 - a. Entering and leaving air temperature.
 - b. Entering and leaving water temperature.
 - c. Water flow.
 - d. kW draw on electric coils.
 - e. Room air temperature.
- 14. Existing & New Perimeter Fin Tube:
 - a. Entering and leaving water temperature.
 - b. Entering and leaving water pressure.
 - c. Water flow.
 - d. Room air temperature.

3.6 REPORT

- A. Provide a general information sheet listing:
 - 1. Instruments used:
 - a. Most recent calibration date.
 - 2. Method of balancing.
 - 3. Altitude correction.
 - 4. Manufacturer's performance data for all air devices used.

- B. Provide data sheets for all equipment, including motors and drives, listing:
 - 1. Make
 - 2. Size
 - 3. Serial number
 - 4. Capacity Rating
 - 5. Amperage
 - 6. Voltage input
 - 7. Thermal heater size for each motor
 - 8. Operating speed of driver and driven devices
 - 9. Any additional pertinent performance data
- C. Include design and final values for all items listed in Detailed Requirements, and totals for each system.
- D. Provide data sheets showing:
 - 1. Air flow at each inlet and outlet
 - 2. Instrument used
 - 3. Velocity reading
 - 4. Manufacturer's free area factors
- E. Provide recap sheet with explanation for each device not meeting specified performance.
- F. Provide a set of prints with equipment, inlets and outlets marked to correspond to data sheets.

3.7 COMMISSIONING

- A. Reference Section 23 08 00 for commissioning scope.
- B. Provide all necessary personnel, tools and equipment to comply with the commissioning scope.

END OF SECTION 23 05 93

SECTION 23 07 00 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Submit manufacturer's product data on the following:
 - 1. Insulation.
 - 2. Jackets, coatings and protective finishes.
 - 3. Sealers, mastics and adhesives.
 - 4. Fitting covers.
 - 5. Manufacturer's installation details for fire rated duct wrap.
 - 6. Low-Emitting Adhesives and Sealants EQc4.1 requirements for LEED submittals.

1.2 FLAME AND SMOKE RATINGS

- A. Provide insulation tested on a composite basis (insulation, jacket, covering, sealer, mastic and adhesive) complying with the following:
 - 1. Flame Spread: 25 or Less
 - 2. Smoke Developed: 50 or Less
 - 3. Method: ASTM E84 (NFPA 255)

1.3 PRODUCT DELIVERY

- A. Deliver insulation products in factory containers bearing manufacturer's label showing fire hazard rating, density and thickness.

1.4 DEFINITIONS

- A. Exposed Location: Located in mechanical rooms or other areas exposed to view.
- B. Concealed Location: Located in pipe chases, furred spaces, attics, crawl-spaces, above suspended ceilings, or other locations not exposed to view.

1.5 STANDARDS

- A. Comply with the latest edition of National Commercial and Industrial Insulation Standards.
- B. Comply with the latest edition of the California Energy Commission Title 24 requirements.

PART 2 - PRODUCTS

2.1 PIPE INSULATION

A. Manufacturers:

1. 3M
2. Aeroflex
3. Armacell
4. ITW
5. Johns-Manville
6. K-Flex
7. Knauf
8. Manson Insulation
9. Owens-Corning
10. Unifrax

B. Materials:

1. **Type FP** - Fiberglass Pipe Insulation: Johns-Manville Micro-Lok heavy density pipe insulation with AP-T jacket.
2. **Type FPF** - Fiberglass Pipe Fitting Insulation: Johns-Manville “Zeston” fitting covers with factory-cut fiberglass insulation insert.
3. **Type FCCP** - Flexible Closed Cell Pipe Insulation: Armacell AP Armaflex, Aeroflex Aerocel, or K-Flex Insul-Tube. Compliant with ASTM E 84, NFPA 90A, and NFPA 90B.
4. **Type FCCP-O** – UV Resistant Flexible Closed Cell Pipe Insulation: Armacell UT Solaflex, Aerocel AC, K-Flex Insul-Tube with AL Clad System.
5. **Type CGP** - Cellular glass with vapor barrier coating: Owens Corning FOAMGLAS.
6. **Type RCCP** - Rigid Closed Cell Insulation (not for use indoors): ITW Trymer 2000XP, Dyplast ISO-C1/2.0, or GLT Products ISO-C1.
7. **Type PFW** - Plenum Fire Wrap: 3M Fire Barrier Plenum Wrap 5A+ or Unifrax FyreWrap 0.5 Plenum Insulation.

Materials indicated are provided as design basis. Equivalent insulation product by manufacturer indicated above is acceptable.

C. Insulation thickness and conductivity: (Thickness and conductivity listed below are minimum required. Provide thickness and conductivity required by Local Building or Energy Codes).

1. Service (Domestic) Water Piping:

- a. Hot, 140°F and under: (Insulation conductivity: 0.21–0.28 (Btu x in.)/(h x ft² x °F))
 - 1) Sizes smaller than 1-½”: 1”
 - 2) Sizes 1-½” and larger: 1-½”

- b. Cold, 40°F to 60°F: (Insulation conductivity: 0.21–0.27 (Btu x in.)/(h x ft² x °F))
 - 1) Sizes smaller than 1-½": ½"
 - 2) Sizes 1-½" and larger: 1"
- 2. Heating Hot Water
 - a. All heating hot water piping: (Insulation conductivity: 0.25–0.29 (Btu x in.)/(h x ft² x °F))
 - 1) Sizes smaller than 1-½": 1-½"
 - 2) Sizes 1-½" and larger: 2"
- 3. Chilled Water, Brine and Refrigerant:
 - a. 40°F to 60°F: (Insulation conductivity: 0.21–0.27 (Btu x in.)/(h x ft² x °F))
 - 1) Sizes smaller than 1-½": ½"
 - 2) Sizes 1-½" and larger: 1"
 - b. 40°F and under: (Insulation conductivity: 0.20–0.26 (Btu x in.)/(h x ft² x °F))
 - 1) Sizes smaller than 1": ½"
 - 2) Sizes 1" and larger but smaller than 8": 1"
 - 3) Sizes 8" and larger: 1-½"
- 4. Storm Water:
 - a. All Sizes: 1"
- 5. Refrigerant Suction Lines:
 - a. 40°F to 60°F: (Insulation conductivity: 0.21–0.27 (Btu x in.)/(h x ft² x °F))
 - 1) Sizes smaller than 1-½": ½"
 - 2) Sizes 1-½" and larger: 1"
 - b. 40°F and under: (Insulation conductivity: 0.20–0.26 (Btu x in.)/(h x ft² x °F))
 - 1) Sizes smaller than 1": ½"
 - 2) Sizes 1" and larger but smaller than 8": 1"
 - 3) Sizes 8" and larger: 1-½"
- 6. Refrigerant Liquid Lines:
 - a. All Sizes: ½" (1" for fiberglass)

7. Refrigerant Hot Gas Lines:
 - a. Sizes smaller than 1-1/2": 1/2"
 - b. Sizes 1-1/2" and larger: 1"
8. Repairs to Existing Insulation: Match thickness of existing insulation.
9. All Heat Traced Piping: (Insulation conductivity: 0.27 or less (Btu x in.)/(h x ft² x °F))
 - a. Refer to specification section 230503 Basic Mechanical Materials and Methods for insulation thickness.
10. Condensate Drain Piping:
 - a. All sizes: 1/2" (1" for fiberglass)
11. PVC pipe in plenums or above noise sensitive areas:
 - a. All sizes: See Part D.

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

1. Inside, above ground: **Type FP** fiberglass.
2. Inside exposed: **Type FP** fiberglass with PVC jacket (jacket not required in mechanical rooms).
3. Outside building envelope:
 - a. Insulation thickness 1-1/2" and larger **or** line size 2-1/2" and larger: **Type RCCP** rigid closed cell with aluminum jacket.
 - 1) Provide sealant at all point joints to maintain vapor barrier.
 - 2) Sealant shall be per insulation manufacturer recommendation.
 - 3) Sealant submittal shall include a letter from the insulation manufacturer verifying that proposed sealant is compatible with insulation.
 - b. Insulation thickness less than 1-1/2" **and** line size less than 2-1/2": **Type FCCP-O** UV resistant flexible closed cell with aluminum jacket or flexible PVC insulation protector, Airex E-Flex or approved equal.
4. Below grade or slab:
 - a. Pipe size 1 1/2" and less: Single piece of **Type FCCP** flexible closed cell insulation slipped over soft annealed copper tube without slitting insulation.
 - b. Pipe size 2" and larger: **Type RCCP** rigid closed cell insulation with shrink fit jacket.

5. PVC piping in return air plenum: **Type PFW** plenum fire wrap to meet ASTM E84 (NFPA 255) flame spread and smoke developed ratings. Thickness to be provided in accordance with manufacturer's literature
6. Acid waste/vent in return air plenums: **Type FCCP** flexible closed cell insulation.
7. Refrigerant piping, inside, above ground: **Type FCCP** flexible closed cell insulation.
8. Refrigerant piping, outside building envelope: **Type FCCP-O** UV resistant flexible closed cell insulation.
9. Condensate drain piping: **Type FCCP** flexible closed cell or **Type FP** fiberglass insulation.

2.2 DUCT INSULATION

A. Manufacturers:

1. Aeroflex
2. Armacell
3. Certainteed
4. Johns Manville
5. K-Flex
6. Knauf
7. Owens-Corning

B. Materials:

1. **Type FDL** – Fiberglass Duct Liner: See Section 23 31 13, for duct liner requirements.
2. **Type FCCL** – Flexible Closed Cell Duct Liner: See Section 23 31 13, for duct liner requirements.
3. **Type FDW** - Flexible Faced Fiberglass Ductwork Insulation Wrap: Johns-Manville Microlite, with FSK factory applied foil-scrim-kraft facing. ASTM E 84 compliant.
4. **Type RDB** - Rigid Fiberglass Ductwork Insulation: Johns-Manville 800 Series, Spin-Glas Type 814, 3 lb. Density rigid board with FSK jacket.
5. **Type RDB-O** - Rigid Glass Mineral Wool Ductwork Insulation: Knauf Earthwool with all service jacket (ASJ).
6. **Type FD** - Flexible Plain Fiberglass Ductwork Insulation: Johns-Manville Microlite .75 lb/cu. Ft. unfaced.
7. **Type FCCD** - Flexible Closed Cell Duct Insulation: Armacell AP Armaflex, Aeroflex Aerocel, or K-Flex Insul-Sheet. ASTM E 84 compliant. Where located outside the building envelope, provide UV resistant paint.
8. **Type CGD** - Cellular Glass Ductwork Insulation: Owens Corning FOAMGLAS with vapor barrier.
9. **Type ALJ** - Outdoor Aluminum Jacket: 3M Venturclad 1579 GCW-WME with white finish, Polyguard Alumaguard Cool Wrap with white finish, or MFM Flex Clad 400 with white finish.

10. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles, and similar accessories as recommended by the insulation manufacturer for the applications indicated.

Materials indicated are provided as design basis. Equivalent insulation or jacketing product by manufacturer indicated above is acceptable.

C. Application:

SYSTEM	EXPOSED	CONCEALED	OUTDOOR
Supply (Note 7)	None	1 ½" Type FDL duct liner	1 ½" Type FDL internal liner + 1 ½" Type RDB-O external rigid + Type ALJ jacket (Note 4)
Return (Note 8)	1 ½" Type FDL duct liner	1 ½" Type FDL duct liner	1 ½" Type FDL internal liner + 1 ½" Type RDB-O external rigid + Type ALJ jacket (Note 4)
Exhaust (Note 8)	None (Note 6)	None (Note 6)	1" Type RDB-O external rigid + Type ALJ jacket (Note 4)
Outside Air (Note 7 & 9)	1" Type RDB external rigid	1 ½" Type FDW duct wrap	2" Type RDB-O external rigid + Type ALJ jacket (Note 4)

- Reference 23 07 00/ Duct Insulation and 23 31 13/ Duct Liner.
- Where energy codes require additional insulation over that listed above, provide insulation in accordance with those codes.
- Insulate all accessories and components (fire dampers, silencers, air valves, etc.) of the duct systems noted above as requiring insulation. Where lined systems contain components that cannot be lined or have not been provided with liner, insulate them. That insulation shall overlap the lined portion of the system by at least 12 inches.
- Build up and pitch insulation to prevent water ponding on rectangular ductwork 36" or greater in width.
- Round ducts concealed above ceilings and serving individual terminal units or diffusers may be wrapped in lieu of liner.
- Provide insulation of exhaust louver plenums and exhaust ductwork for first 20' from perimeter louvers or from perimeter louver to motorized damper or gravity damper. Provide **Type FDL** duct liner for exposed exhaust louver plenums and ductwork. Provide **Type FDW** duct wrap for concealed exhaust louver plenums and ductwork.
- Ductwork downstream of 100% outside air units with heating and cooling shall be treated as supply air.
- All negative pressure ductwork of energy recovery ventilators shall be treated as return air.
- Boiler plant combustion air ductwork shall be insulated as outside air ductwork. Round ductwork may be wrapped in lieu of external rigid insulation.

2.3 EQUIPMENT INSULATION

A. Manufacturers:

1. Aeroflex
2. Armacell
3. Certainteed
4. Johns Manville
5. K-Flex
6. Knauf
7. Manson Insulation
8. Owens-Corning

B. Materials:

1. **Type FE** – Fiberglass Pipe and Tank Insulation: Johns-Manville Micro-Flex Large-diameter Pipe and Tank Fiberglass Insulation. Insulation shall be designed to conform to curved surfaces while maintaining insulation thickness and high compressive strength.
2. **Type FCCE** - Flexible Closed Cell Insulation: Armacell AP Armaflex, Aeroflex Aerocel, or K-Flex Insul-Sheet, sheet form. ASTM E 84 compliant.
3. Jacketing Material: PVC roll jacketing. Seal all joints.
4. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors, stud pins, metal covers, adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

C. Application:

1. Thickness: Refer to Part 3.
2. Inside, above ground: **Type FE** pipe and tank insulation.
3. Inside, exposed: **Type FE** pipe and tank insulation with PVC jacket (jacket not required in mechanical rooms).
4. Outside building envelope: **Type FCCE** flexible closed cell with UV resistant painted finish, white in color unless otherwise noted. Paint shall be by same manufacturer as insulation.
 - a. Provide sealant at all point joints to maintain vapor barrier.
 - b. Sealant shall be per insulation manufacturer recommendation.

2.4 KITCHEN GREASE HOOD EXHAUST DUCT INSULATION/FIRE BARRIER DUCT WRAP

A. Manufacturers (all components to be by one manufacturer):

1. 3M
2. ETS Schaefer
3. Nelson
4. Pyroscat

5. Thermal Ceramics
6. Unifrax
7. Vesuvius

B. Materials:

1. Lightweight, non-asbestos, high temperature inorganic ceramic fiber blanket wrap.
2. Insulation to be fully encapsulated in reinforced foil.
3. Double layer, two (2) hour fire resistant enclosure.
4. Fibers to be non-carcinogen and soluble in human lung tissue.
5. Zero clearance to combustibles rating.
6. Provide rated access doors (as required) insulated to maintain two (2) hour rating and required clearance.
7. Provided fire barrier sealant, tape, rods, pins, clips, bands and other components as required to provide fully functioning system.
8. Systems using spray applications or combination ratings of duct material and spray are not acceptable.

C. Listings and Testing:

1. ISO 6944: Fire resistance tests – Ventilation ducts
2. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials
 - a. Surface burning characteristics:
 - 1) Flame Spread: 0
 - 2) Smoke Developed: 0.
3. ASTM E814: Standard Test Methods for Fire Tests of Through-Penetration Firestops
4. ASTM E119: Standard Test Methods for Fire Tests of Building Construction Materials
5. NFPA 96.
6. NFPA 101.
7. Submit written approval from authority having jurisdiction for use of system at specified clearance.

D. Application:

1. Insulate duct systems as indicated on drawings. Insulate life safety ductwork as indicated in Section 23 09 03.
2. Wrap duct supports for two (2) hour rating.
3. Install per manufacturer's recommended installation guidelines.
4. Provide Manufacturers approved transition between fire wrap and gypsum board rated enclosures where both systems are used. Do not transition from gypsum enclosure system back to fire wrap.
5. Use bands and/or welded pins as required. Adhesives are not acceptable.

PART 3 - EXECUTION

3.1 GENERAL

- A. Verify acceptability of all materials which are to be used in air plenums (above ceiling, etc.). Materials must meet all requirements of Local Building Code and Authority having jurisdiction.

3.2 PIPE INSULATION

- A. Insulate the following:
1. Domestic hot water piping.
 2. Domestic cold-water piping above ground and under slab.
 3. Heating piping.
 4. Chilled water piping.
 5. Roof drain bodies and all horizontal storm water piping.
 6. Refrigerant hot gas, liquid, and suction lines.
 7. All existing piping which is currently insulated and which is modified as a result of this work.
 8. Condensate drain piping.
 9. Heat traced piping.
 10. Storm and sanitary piping where subject to freezing conditions.
 11. All PVC piping located in return air plenums.
- B. Installation:
1. Install insulation on pipe system subsequent to testing and acceptance of tests.
 2. Install insulation materials with smooth and even surfaces.
 - a. Insulate each continuous run of piping with full length units of insulation, with a single cut piece to complete the run.
 - b. Do not use cut pieces or scraps abutting each other.
 3. Clean and dry pipe surfaces prior to insulating.
 - a. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
 4. Extend piping insulation without interruption through pipe clamps, hangers, walls, floors and similar piping penetrations, except where otherwise indicated. **Hangers and supports must be installed outside, not through, insulation.**
 5. Install protective metal shields and saddles where needed to prevent compression of insulation. Refer to Section 23 05 29.

6. Except as noted, cover valves, flanges, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run.
 - a. Install factory-molded, pre-cut or job-fabricated units (at Installer's option), except where a specific form or type is indicated.
 - b. Do not cover:
 - 1) Valve operators.
 - c. Provide removable access for:
 - 1) Strainers.
 - 2) Other components requiring access for service.
7. Mark location of unions and flanges covered by insulation with permanent paint or ink, or approved label.
8. Maintain integrity of vapor-barrier jackets on insulation of cold pipes and storm drainage piping, and protect to prevent puncture or other damage.
9. Insulate between pipe and pipe saddles. Provide suitable saddles.
10. Seal ends of sections with vapor barrier cement to create moisture dams at:
 - a. 21 ft. intervals.
 - b. Valves and fittings.
 - c. All hangers and supports.
11. On underground pipe insulation, install unicellular insulation on pipe without slitting insulation.
 - a. Seal all transverse joints with adhesive.
12. Replace existing insulation removed or damaged because of work of this project.
13. Insulate new pipes and replace insulation on existing pipes to remain where insulation was removed or damaged by demolition or revisions.
14. Do not insulate basket access flange of flanged strainers.
15. Do not insulate steam traps.
16. Insulate between fingers of spiders in alignment guides.
17. Insulate between pipe and pipe slide.
18. Perform all work in a neat and workmanlike manner. Poor work (as determined by Architect or Engineer) will be cause for rejection.

3.3 UNDERGROUND HYDRONIC PIPE INSTALLATION

- A. Portions of the chilled water and heating water piping systems shall be insulated below grade.
- B. The installed piping system shall have the following characteristics.

- C. Insulating Value: The system shall provide a conductivity of 0.165 Btu-in/hr ft² F° at 75°F (r-value of 6).
1. The insulation shall be Foamglass Pittwrap SS II, waterproof (not lose insulating value when saturated with liquid water or completely sealed against the introduction of water) and 2" thick.
 2. The exterior of the pipe shall be completely sealed against the introduction of moisture when the system has been installed in ground water saturated fill.
 3. The system shall be compatible with the excavation and backfilling methods and materials used.
 4. The system shall be able to sustain medium duty tract loading (1000 lb wheel loading at the surface) without damage.
- D. Minimum burial depth shall be 5'-0" below finished grade.
- E. The actual system used shall be at contractor's option as long as the above criteria is met, and may be a pre-fabricated or field built system. However, if the system submitted by the Contractor does not meet the criteria (as determined by Engineer), the Contractor shall supply a double pipe pre-fabricated system equivalent to that manufactured by Ricwil or Perma-Pipe.

3.4 OUTDOOR PIPE INSULATION

- A. Install rigid insulation with butt joints of half pipe sections staggered. Insulation shall be held in place with strapping tape.
- B. Install aluminum jacket with all joints lapped to shed water. Apply a bead of silicone sealant at all transverse and longitudinal seams. Secure with aluminum bands, minimum of 2 per jacket section. Contractor to verify that sealant has been applied per sealant and insulation manufacturer recommendations for proper vapor barrier.
- C. Install flexible PVC insulation protector per manufacturer's installation requirements. Contractor to verify that insulation protector has been applied per insulation protector and insulation manufacturer recommendations for proper vapor barrier.

3.5 DUCTWORK INSULATION

- A. Install insulation materials with smooth and even surfaces.
- B. Clean and dry ductwork prior to insulating.
 1. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

- C. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated. **Hangers and supports must be installed outside, not through, insulation.**
- D. Except as otherwise indicated, do not insulate lined ducts. However, extend duct insulation 12" beyond start of lining where lined ductwork meets insulated ductwork.
- E. Maintain integrity of vapor-barrier on insulation of ducts carrying cold air, and protect it to prevent puncture and other damage.
- F. For Outdoor Insulation:
 - 1. Stagger joints on multilayer applications.
 - 2. Locate joints at sides of ducts whenever possible.
 - 3. Utilize adhesive and vapor retarder as indicated by manufacturer for outdoor applications.
 - 4. Use full coverage adhesive to adhere external insulation to ductwork. For flexible closed cell insulation, adhesive shall be by insulation manufacturer.
 - 5. Vapor retarders shall overlap a minimum of 2" at all seams.
 - 6. Cover flexible connections.
 - 7. Extend covering to inside face of wall/roof.
 - 8. Provide all exposed rigid insulation surfaces with protective aluminum jacket. Provide backing and aluminum jacketing tape at all sharp edges and fasteners. Do not puncture aluminum jacket.
 - 9. Provide all outdoor flexible closed cell insulation with UV resistant painted finish, white in color unless otherwise noted. Paint shall be by same manufacturer as insulation.

3.6 EQUIPMENT INSULATION

- A. Install insulation materials with smooth and even surfaces and on clean and dry surfaces.
 - 1. Re-do poorly fitted joints.
 - 2. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.
- B. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.
- C. Apply insulation using the staggered joint method for both single and double layer construction, where feasible.
 - 1. Apply each layer of insulation separately.
- D. Do not insulate handholes, cleanouts, ASME stamp and manufacturer's nameplate.
 - 1. Provide neatly beveled edge at interruptions of insulation.

E. Chilled Water Pumps:

1. Do not insulate. Provide drain pan and drain to collect condensate formed on pump body. Pipe drain line to nearest floor drain and provide air gap.

F. Hot Equipment (Above Ambient Temperature):

1. Includes hot and heating water as well as steam equipment such as air release tanks, air separators, expansion tanks, flash tanks, vessels etc.
2. Insulate with 3" thick equipment insulation.
3. Do not apply insulation to equipment while hot.

G. Heat Exchanger:

1. Cover top and both sides of exchanger with 24-gauge galvanized steel panels with ½" **Type FCCE** flexible closed cell equipment insulation cemented to the inside of the panels.
2. Panels shall be easily removable and easy to re-install.
3. Adhere flexible closed cell insulation to end plates with Armacell Armaflex No. 520 adhesive or equivalent by selected insulation manufacturer.

H. Domestic Water Tanks:

1. Insulate domestic hot water tanks with 2 inches of equipment insulation or 1½ inches of rigid fiber glass board (if not originally insulated from the factory).

I. Cold Equipment (At or below ambient equipment):

1. Includes chilled, domestic cold, condenser water system equipment such as air release tanks, air separators, expansion tanks, flash tanks, vessels, etc.
2. Insulate air release tanks (air separators) with 2 inches of equipment insulation or 1½ inches of cellular glass insulation.

3.7 FIRE RATED DUCT WRAP

- A. Remove dirt and dust and clean all duct surfaces.
- B. Install per manufacturer's instructions and referenced standards. Where pins are required, they shall be tack welded to duct.
- C. Repair any damage in accordance with manufacturer's instruction.

3.8 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily. Including units with vapor barrier damage and moisture saturation.

- B. Protection: The insulation installer shall advise the Contractor of required protection for the insulation work during the remainder of the construction period, to avoid damage and deterioration.

3.9 ASBESTOS REMOVAL

- A. It is understood and agreed that this work does not contemplate handling of, or design including use of, asbestos or any hazardous waste material. Therefore, Owner and Contractor agree to hold harmless, defend and indemnify consultant (A/E) for all claims, lawsuits, expenses or damages arising from or related to the handling, use, treatment, purchase, sale, storage or disposal of asbestos, asbestos products or any hazardous waste materials.
- B. In the event asbestos is encountered the Contractor shall immediately cease work in the area of the asbestos shall contact the Engineer and Owner for instructions.
- C. Regulations:
1. Follow Section 1910.1001 Code of Federal Regulations Title 29, Part 1910 (OSHA Asbestos Regulations).
 2. Provide daily sampling during removal instead of at six month intervals.
 3. Stop work and notify Architect immediately if levels exceed those of Subparagraphs b (2) or b (3) of regulations.
 4. Dispose of material containing asbestos using methods approved by EPA at sites approved by EPA.

END OF SECTION 23 07 00

SECTION 23 08 00 - BUILDING MECHANICAL SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The requirements of the General Conditions, Supplemental Conditions and Section 23 05 02 apply to all work specified in this section.
- B. Refer to Specification Section 23 05 93, title "Test and Balance" for interface requirements with test and balance contractor.

1.2 DESCRIPTION OF WORK

- A. This specification covers the start-up, operating performance test and commissioning of the HVAC systems. The purpose of this effort is to bring the project mechanical systems to a state of dynamic operation in accordance with the contract documents by verifying the operation of individual components, subsystems and systems.
- B. The Owner will retain the services of an independent commissioning agent (CxA) separate from the work of this Contract. As herein specified the Owner and CxA shall develop detailed commissioning procedures, equipment checkout procedures and data forms for recording compliance with contract documents, performance and punchlist deficiencies, and will assist in developing schedules for checkout and Owner acceptance, at a future date during the construction phase.
- C. The Division 23 Mechanical Contractor and the General Contractor shall include as part of the work of this contract, labor and material to provide manpower, equipment, tools, ladders, instruments, etc. necessary to accomplish the work and labor and material for execution, monitoring and printing data forms necessary to verify and record system observations.
- D. The Test and Balance Contractors shall include as part of the work of this contract, labor and material to provide manpower, equipment, tools, ladders, instruments, etc. necessary to execute and accomplish the work.
- E. At the completion of the start-up, operations performance test and test and balance, the Contractor shall conduct a 72 hour dynamic mode demonstration of the systems in the presence of the Owner/Architect/Engineer and CxA.

1.3 COMMISSIONED EQUIPMENT

- A. All equipment requiring commissioning as indicated in the 2018 International Energy Conservation Code.

1.4 COMMISSIONED SYSTEMS

- A. All systems requiring commissioning as indicated in the 2018 International Energy Conservation Code.

PART 2 - PRODUCTS

2.1 MATERIALS, LABOR, INSTRUMENTS, TOOLS, LADDERS AND APPARATUS

- A. The Contractor shall provide all materials, labor, instruments, tools, ladders and apparatus necessary to start-up, perform operating performance test and systems conditioning.
- B. The Contractor shall be responsible for maintaining the commissioning documentation until final acceptance of the project. Final checklists will be produced by the CxA and provided prior to beginning commissioning. The commissioning documentation shall be kept current by the Contractor and shall be available for inspection at all times. At the time of acceptance of the project, the Contractor shall surrender 3 completed copies of the commissioning documentation to the Owner's representative.

PART 3 - EXECUTION

3.1 START-UP AND OPERATING PERFORMANCE TEST

- A. Before request for contract compliance inspection and system commissioning all equipment, components, and systems shall be started-up, adjusted, calibrated; set, test and check all electric disconnect, fuses, circuit breakers, valves, dampers, temperatures and pressures of all systems for proper operation and performance. After completion of the start-up and operating performance test, the Contractor will notify the Owner in writing that the system is ready for commissioning.
- B. Information, data, etc. from start-up and operating performance test may be utilized, as appropriate, to execute preliminary commissioning documentation, however, certification of equipment and systems for the preliminary commissioning phase shall be completed in accordance with paragraph 3.2 of this section of the specifications.
- C. Start-up and operating performance test documentation shall include the following:
 - 1. Energy Recovery Ventilator Systems:
 - a. Total supply air CFM, fan speed, inlet pressure, outlet pressure, amp draw.
 - b. Total exhaust air CFM, fan speed, inlet pressure, outlet pressure, amp draw.
 - c. Filter pressure drop.
 - d. Energy recovery wheel RPM, inlet pressure, outlet pressure, and amp draw.

- e. Coil airflow.
 - f. Coil entering and leaving air temperature.
 - g. Coil entering and leaving air pressure.
 - h. Coil water flow.
 - i. Coil entering and leaving water temperature.
 - j. Coil entering and leaving water pressure.
 - k. Duct temperature at duct mounted temperature sensor.
 - l. Duct static pressure at supply and exhaust duct mounted pressure sensors.
2. Ductwork Systems:
- a. Airflow at each inlet and outlet.
 - b. Airflow at supply, return, outside air, and exhaust mains to determine total airflow.
 - c. VAV box entering and leaving air temperature.
 - d. VAV box entering and leaving static pressure.
 - e. VAV box airflow at minimum position, maximum position, and heating position.
3. Fan Coil Unit Systems:
- a. Supply fan airflow, fan speed, total static pressure, and amp draw.
 - b. Coil entering and leaving air temperature.
 - c. Coil water flow.
 - d. Coil entering and leaving water temperature.
 - e. Coil entering and leaving water pressure.
 - f. kW draw on electric coils.
 - g. Space temperatures at thermostats or sensors.
4. Environmental Fans:
- a. Total fan CFM.
 - b. Fan speed.
 - c. Fan total static pressure.
5. Gas-fired Makeup Air Units:
- a. Air flow.
 - b. Entering and leaving air temperature.
 - c. Entering and leaving static pressure.
 - d. Gas pressure.
 - e. Combustion air fan operation.
 - f. Flue temperature.
 - g. Start/stop controls.
6. Coils:
- a. Coil airflow.
 - b. Coil entering and leaving air temperature.

- c. Coil entering and leaving air pressure.
 - d. Coil water flow.
 - e. Coil entering and leaving water temperature.
 - f. Coil entering and leaving water pressure.
7. Heat Exchangers:
- a. Cooler fluid entering temperature, leaving temperature, and fluid flow.
 - b. Warmer fluid entering temperature, leaving temperature, and fluid flow.
8. Air-cooled Chiller:
- a. Cooling water flow.
 - b. Cooling water temperature entering and leaving.
 - c. Cooling water pressure entering and leaving.
 - d. Evaporative-pre cooling system booster pump amp draw.
 - e. Compressor safety and operating controls.
 - f. Compressor amps and kW draw.
 - g. Capacity reduction controls.
 - h. Free cooling coil operation.
 - i. Refrigerant suction pressure.
 - j. Low ambient controls for packaged chiller systems.
9. Boilers:
- a. Heating water temperature entering and leaving.
 - b. Heating water flow.
 - c. Heating water pressure entering and leaving.
 - d. Boiler safety and operating controls.
 - e. Capacity reduction controls.
 - f. Stack temperatures.
 - g. Gas pressure and cubic feet of gas per hour.
 - h. Combustion efficiency.
 - i. If boiler is equipped for variable firing rates, include data for a. through h. for maximum and minimum firing rates.
 - j. Manufacturer's start-up report may be substituted if all above measurements are included.
10. Pumps:
- a. Water flow.
 - b. Entering and leaving water pressure.
 - c. Motor amps and kW draw.
 - d. Installed impeller diameter.

11. Split system air conditioners and heat pumps:
 - a. Refrigerant suction pressure.
 - b. Fan operation.
 - c. Compressor operation.
 - d. Low ambient controls.
 - e. Automatic restart upon loss and regain of electrical power.
12. Controls:
 - a. Operational setting of controllers and instruments.
 - b. Positioning and function of valves and dampers.
 - c. Interlock and operation of systems (HVAC and Fire).
13. Cabinet Heaters and Unit Heaters:
 - a. Entering and leaving air temperature.
 - b. Entering and leaving water temperature.
 - c. Water flow.
 - d. kW draw on electric coils.
 - e. Room air temperature.
14. Existing & New Perimeter Fin Tube:
 - a. Entering and leaving water temperature.
 - b. Entering and leaving water pressure.
 - c. Water flow.
 - d. Room air temperature.

3.2 SYSTEM COMMISSIONING

- A. All systems, components, equipment, etc. furnished as part of this Contract shall be subjected to system commissioning as hereinafter specified. All systems, components, equipment, etc. commissioned in this section of the Specifications shall be evaluated based on the sequences of control/operation, performance characteristics, and equipment schedules, etc. as specified in other sections of the Specifications and as shown on the contract drawings. Systems, components, equipment, etc. that does not have specified operating sequence, etc. shall be operated and evaluated based on its use and function for this project.
- B. Commissioning Documentation: The Contractor shall maintain the commissioning documentation in 3-ring binders. The commissioning documentation shall be organized by

system when practicable. All pages shall be numbered and a table of contents page shall be provided. The commissioning documentation shall include, but not be limited to, the following:

1. Design Criteria provided by the A/E.
 2. Approved Test and Balance Report for the system or component being commissioned, provided by Test and Balance Contractor.
 3. Approved submittals for all equipment to be commissioned, provided by Mechanical Contractor.
 4. All approved shop drawings of equipment to be commissioned. Shop drawings shall be full size sheets folded as required to fit in binders. Provided by Mechanical Contractor.
 5. All pre-commissioning checklists initialized by indicated personnel organized by system and subsystem.
 6. All functional performance test checklist initialized by indicated personnel organized by systems and subsystems.
 7. Three copies of the Operation and Maintenance Manuals specified in other sections of these specifications shall be reviewed by the CxA for completeness and for applicability. The manuals shall be incorporated in the Commissioning Documentation prior to the commencement of the training required in other sections of the specifications. Preparation of Operation and Maintenance Manuals shall be as specified in other sections of these specifications.
- C. Shop Drawings and As-Built Drawings and Specifications shall be assembled by the Contractor after completion of the pre-commissioning phase and turned over to the Owner's representative. Changes as a result of subsequent Commissioning procedures will be incorporated (as required) at the conclusion of final Commissioning.
- D. Commissioning Schedule:
1. Phase 1 - Preliminary Commissioning: All shop drawings, including but not limited to, equipment, controls, test and balance reports, and operation and maintenance manuals, shall be submitted and approved by the CxA. In addition, all pre-commissioning checklists shall be completed (initialed by all parties).
 2. Phase 2 - Functional Performance Testing shall be performed as indicated on the Functional Performance Test Checklists. Functional Performance Testing shall not begin until Phase 1 of the commissioning process is complete. Owner's operation and maintenance personnel shall observe the function performance testing. The Contractor may perform initial system familiarization and training of Owner's operating and maintenance personnel required under other sections of the Specification during the functional performance testing.
 3. Functional Performance Test Notification: The Contractor shall notify the CxA 2 weeks before functional performance testing is to begin.
 4. Phase 3 - System training and operating instructions shall be conducted by the Contractor as indicated in the specifications of each item of equipment. The Contractor shall be responsible for specified training and operating instructions being observed by the CA.

E. Pre-Commissioning Checklists:

1. Pre-Commissioning Checklists shall be developed by the CxA and shall be executed and certified prior to the commencement of functional performance testing. The indicated initial is required in each location for all items, except where an "X" is shown indicating an initial is not required. See initials legend below for required initials. The pre-commissioning checklist will not be accepted as complete until all items have been initialed signifying this portion of the project is ready for Functional Performance Testing. The Contractor shall provide the CxA with the completed Pre-Commissioning Checklists for his review and initials. The CxA shall be the last person to initial each checklist item. The Contractor shall submit for approval a list of all contractor and subcontractor representatives responsible for the completion of the pre-commissioning checklist phase of the project. This list of representatives shall be submitted 2 weeks prior to commencement of any pre-commissioning activities of any systems or equipment. Representatives may be replaced only after written approval from the CxA.
2. Initials Legend:
 - a. Construction Manager.
 - b. Mechanical Contractor's representative.
 - c. Electrical Contractor's representative.
 - d. Commissioning Agent.
 - e. Balancing Contractor's representative.
 - f. Controls Contractor's representative.
3. Blank Example Pre-Commissioning Checklists are in Appendix, located at the end of this section of the specifications. A separate Pre-Commissioning checklist shall be provided for each system and piece of HVAC equipment to be Commissioned.

F. Functional Performance Test Checklist:

1. Functional performance testing shall be performed by the Contractor as directed by the CA and observed by a commissioning team consisting of the individuals indicated on the Functional Performance Test Checklists. The Contractor shall submit in writing a list of all contractor and subcontractor representatives responsible for the functional performance testing phase of the project. This list of representatives shall be submitted 2 weeks prior to the commencement of functional performance testing of systems and equipment. All representatives shall remain on the commissioning team throughout functional performance testing. Substitutions will not be permitted. Functional performance test checklists shall be completed in the presence of all commissioning team personnel at the time of the functional performance test.
2. Upon failure of completion of a functional performance test checklist, the Contractor shall provide a written report to the CxA listing the deficiencies causing the failure and remedies to correct all deficiencies. After the Contractor has corrected all deficiencies, the entire functional performance test checklist for the item of equipment shall be repeated. If possible, corrections can be accomplished during the functional performance testing of equipment in other non-related systems. In any case, no system will be

- accepted until all equipment items in the system have complete functional performance test checklists thereby demonstrating satisfactory performance.
3. Failure to complete 2 functional performance test checklists constitutes failure of Phase 2 of the HVAC Commissioning process. The Contractor shall provide a written report to the CxA listing the deficiencies causing all failures and remedies to correct all deficiencies. After correction of all deficiencies, Phase 2 of the HVAC Commissioning process shall be repeated in its entirety. The Contractor shall give the CxA 2 weeks notice before repeat functional performance testing is scheduled. Should the first or one subsequent functional performance test fail, the Owner reserves the right to obtain compensation from the Contractor for fees and expenses incurred in conjunction with having to perform more than two (2) functional performance tests.
 4. Blank examples functional performance test checklists are in the Appendix 2 located at the end of this section of the specifications. A separate Functional Performance Checklist shall be provided for each system and piece of equipment to be Commissioned.

3.3 DEMONSTRATION TEST

- A. After completion of system start-up, operating performance test and commissioning, but before Owner acceptance, the Contractor shall conduct a 72 hour dynamic mode demonstration of the systems provided under this Contract. The intent of the 72 hour dynamic test is to verify that the mechanical and electrical equipment will respond as designed to meet the changes that may occur under varying indoor/outdoor conditions including seasonal variations and occupancy loads.
- B. A detailed procedure and sequence of events shall be developed by the Contractor and submitted to the Owner and CxA for review and approval. Procedures and sequence of events should contain as a minimum the following activities:
 1. Hours 1-4: Bring all systems online for standard operations and parameters.
 2. Hours 5-28: Operate all systems under normal parameters and verify proper operation.
 3. Hours 29-52: Validation of systems operation through indoor/outdoor changes to include heating, cooling, ventilation, humidity control, domestic and control systems.
 4. Hours 69-72: Return of systems to normal operation.
- C. Systems and their associated equipment which are to be included in the dynamic test are all systems and components furnished under this Contract and as a minimum will include, but are not limited to the following:
 1. Pressurization Air Handling Systems
 2. Air Handling Systems
 3. Chilled Water Systems
 4. Domestic Water Systems
 5. Fan Coil Systems
 6. Pumping Systems
 7. Exhaust Systems

8. Air Filtration Systems
9. Building Management and Control Systems

D. Contractor shall notify the Owner and CxA in writing that the project is completed and ready for the demonstration test. Schedule for test will then be established and documented. Initiation of the 72 hours dynamic test will not occur until all systems are balanced, operational and incorporated into the building management and control system. Should the demonstration test fail for any reason, the problems shall be corrected and another demonstration test conducted. Should the first or one subsequent demonstration test fail, the Owner reserves the right to obtain compensation from the Contractor for fees and expenses incurred in conjunction with having to witness more than two (2) 72 hour demonstration tests.

E. The attendees of each 72 hour demonstration test shall include representative from the following organizations:

1. General Contractor
2. Mechanical Contractor
3. Electrical Contractor
4. Test and Balance Contractor
5. Building Management and Control System Contractor
6. Architect of Record
7. Mechanical Engineer
8. Electrical Engineer
9. Commissioning Agent

Minor problems are anticipated and the necessary personnel required to correct problems and adjust systems need to be available to insure continuation of the dynamic testing process. If major problems are encountered, at the discretion of the Owner and CxA, the testing will be terminated and rescheduled.

The Contractor shall notify any external organizations, which would include but not be limited to, the Owner and Fire Department which are not directly involved in the testing, but might be affected due to interface to insure that alarms do not occur.

F. During the demonstration test all systems shall operate in the "hands-off" automatic mode in accordance with the requirements of the Contract Documents. Changes in operating modes required to simulate load shifting, seasonal changeover, emergency modes, etc. will be accomplished by changing set points and equipment operating status at the BMS central control console as required to observe capacity control and monitoring. Provide a readout of space temperature at each thermostat building relative humidity, building pressurization, chilled water supply and return temperatures and chiller capacity.

END OF SECTION 23 08 00

SECTION 23 08 01 - COMMISSIONING AGENT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to section 23 08 00 for commissioning requirements and Division 1 for additional information.

1.2 DESCRIPTION OF THE WORK

- A. This Section covers the Scope of Work for the Commissioning Agent (CxA) who will be hired by the Owner.
- B. The Commissioning Agent shall oversee the commissioning of the HVAC systems as described in Section 23 08 00. The CxA shall prepare precommissioning and functional performance test checklists to be used by the Contractor. Prepare and publish a commissioning plan. Witness startup and operational tests of equipment and systems. Perform observations of the mechanical systems throughout construction and prepare the final commissioning document.
- C. The CxA shall have authority to direct and schedule test. The CxA shall have no authority to direct changes to the systems, or provide design related review comments.

1.3 COMMISSIONING PLAN

- A. The CxA shall prepare a plan listing the parties involved with their responsibility, scope, definitions, safety concerns, design criteria, attendance schedules, commissioning schedules, and commissioning manual requirements.

1.4 COMMISSIONING FORMS

- A. Review 100% CD's. Provide written summary of how each commissioned item of equipment, should operate include calculations verifying scheduled capacity.
- B. The CxA shall develop forms similar to that in Section 23 08 00 for the Contractors use during the commissioning process. The forms shall become part of the final commissioning manual. Forms shall be provided for each piece of commissioned equipment and system. Any deviations from the design shall be noted and proved by the Owner prior to acceptance. Each form shall be signed by the Contractor, CxA and Owner prior to acceptance of a system or piece of equipment.

1.5 PROJECT OBSERVATIONS

- A. The CxA shall perform observations of the commissioned equipment and systems twice a month at a minimum and more as required to keep pace with construction. The CxA shall note progress and any deviations of the construction documents shall be brought to attention of the Contractor and Owner for resolution. The CxA will have no authority to direct changes or corrections to the system. Observation reports shall be published to the Owner, Architect and Contractor and shall be part of the final commissioning manual.

1.6 OPERATIONAL AND START-UP TESTS

- A. The CxA shall witness start-up tests and collect documentation of the tests. The CxA shall notify the Architect and Contractor of any deviations from the contract documents. Any deviations shall be corrected or accepted by the Owner prior to acceptance.
- B. After the Contractor has submitted in writing that the systems are completed, the CxA shall schedule and direct operational tests of the systems. These tests shall be as described in Section 23 09 00 and 23 08 00. The results shall be documented and made part of the commissioning manual. Any deviations from the design shall be brought to the attention of the Architect and Contractor. Any deviations shall be corrected or accepted by the Owner prior to acceptance.

1.7 COMMISSIONING MANUAL

- A. The CxA shall prepare the final commissioning manual. The manual shall provide a complete history of the commissioning process and shall include:
 - 1. Design and Energy Codes.
 - 2. Commissioning Plan.
 - 3. Completed Commissioning Forms.
 - 4. Completed Observation Reports.
 - 5. Completed Start-up Reports.
 - 6. System Operational Tests.
 - 7. Final sequence of operation to be achieved.
 - 8. Summary of building operation as commissioned, noting deviations from design.
 - 9. Design Criteria (extended from Design Documents by CxA).
 - 10. Written summary of normal startup and operating procedures for each commissioned item of equipment.

The manual shall be a three ring binder with tabs for each section. Provide 5 copies.

END OF SECTION 23 08 01

SECTION 23 09 00 - BUILDING AUTOMATION AND AUTOMATIC TEMPERATURE CONTROL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work described under this division is for all labor, materials, and equipment required for the construction of the Building Management System (BMS or BAS/Automatic Temperature Control (ATC) system.
- B. The system shall be complete in all respects, tested and ready for operation.
- C. All materials, equipment and apparatus shall be new and of first-class quality.
- D. Electrical Standards: Provide electrical products which have been tested, listed and labeled by Underwriters' Laboratories and comply with NEMA standards and the National Electric Code.
- E. "Operator" is defined as the Owner's representative designated to operate the BMS/ATC system after Owner acceptance.

1.2 GENERAL INSTRUCTIONS

- A. The BMS/ATC systems as specified herein shall be provided in their entirety by the BMS/ATC Contractor. The BMS/ATC Contractor shall base his Bid on the systems as specified.
- B. The general provision of the contract (Division 1 and sections 23 05 01, 23 05 02, and 23 05 03) apply to work specified in this section.
- C. The successful Contractor shall provide a BMS system board or other hardware (if required) and the required software to Engineer so that internet connection may be made between the project and Engineer's office during the warranty period. The intent is to allow the Engineer lowest level Operator access during system installation, startup and demonstration.
 - 1. This shall be made available to the engineer as soon as available. This Division is responsible for requesting IP address and coordinating software installation and access.

1.3 SCOPE

- A. In general, the proposal shall be based on an electronic system. Valve and damper actuators shall be electronically actuated. Provide electronic sensors and transmitters with full DDC capabilities.

- B. The BMS provided for the Promenade building shall also be used to control systems in the Plaza F&B building, Building B, and Boiler Plant. System shall be expandable to include any connections and functionality required for future scopes of work and appropriate conduit runs and connections shall be included in Phase 1 to accommodate future BMS connectivity.
- C. The engineering, installation, calibration, hardware, software programming and checkout necessary for complete and fully operational BMS/ATC systems, as specified hereafter, shall be provided under this division by the BMS/ATC Installer.
- D. The BMS Contractor shall guarantee that the installed system is capable of maintaining the following comfort goals in conditioned areas served by the BMS.
 - 1. Space Design Temperature +/- 1°F.
 - 2. Relative Humidity +/- 5%.
 - 3. The BMS Contractor is not responsible for improper installation by other Divisions; however, the BMS Contractor is responsible for informing the Construction Manager and Engineer of any requirements of this specification or any installation problem which prevents these goals from being maintained.

1.4 ITEMS REQUIRED TO BE COORDINATED WITH OTHER DIVISIONS

- A. Contractor shall be responsible for coordinating the following:
 - 1. Power requirements (voltage, amps, location) for all BMS equipment requiring power. See Section 23 05 01.
- B. Installation and connection of all power wiring. Power wiring shall be defined as follows:
 - 1. Wiring of power feeds through all disconnect starters and variable speed controllers to electric motors.
 - 2. 120 VAC Emergency and 120V Normal power feeds to all BAS temperature control panels and equipment.
 - 3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by the BAS/ATC Contractor.
 - 4. See Division 23 05 01 for responsibilities.
- C. Note that 120V to 24V surge protected transformers for low-voltage wiring by this Division shall be furnished, set in place and wired (from designated circuit in electrical panel) by this Division, and all low-voltage control wiring shall be installed under this Division.

1.5 WORK BY OTHERS

- A. The following work shall be provided under separate divisions of the specifications:
 - 1. Installation of all line size and non-line size automatic valves and separable wells. However, these devices shall be furnished under this division.
 - 2. Provision of all necessary piping connections, taps and direct-contact wells required for flow, pressure or temperature devices specified under other divisions.
 - 3. Provision of manual balancing dampers as specified under other divisions of Divisions 21 through 23.
 - 4. Installation of all automatic control dampers shall be under Division 31 13. However, all control dampers shall be furnished under this division.

1.6 AGENCY LISTINGS

- A. UL 916 PAZX Energy Management Systems.
- B. FCC-Part 15 Subparagraph J. Class A. Emissions requirements.
- C. UL-864/UUKL Smoke Removal.

1.7 RELATED SECTIONS

- A. 23 05 01 - Mechanical and Electrical Coordination.
- B. 23 05 02 - Basic Mechanical Requirements.
- C. 23 05 03 - Basic Mechanical Materials and Methods.

1.8 BMS/ATC CONTRACTOR

- A. The BMS/ATC Contractor shall have a local office within a 100-mile radius of the job, staffed with factory trained engineers fully capable of providing instruction, routine maintenance and 24-hour emergency maintenance service on all system components. The BMS/ATC Contractor shall have a ten-year experience record in the design and installation of computerized building systems similar in scope and performance to that specified herein, and shall be prepared to provide evidence of this history prior to Contract Award should the Owner request it.
- B. The BMS/ATC Contractor shall be prepared to make a personal presentation of his systems to the Owner or his designated representatives prior to award of Contract should the Owner request it.
- C. The engineering, installation, calibration, hardware, software programming and checkout necessary for complete and fully operational BMS/ACT systems, shall be provided under this division by the BMS/ATC Installer.

- D. Control components shall be mounted and wired by the BAS/ACT Contractor except as noted. Controllers may be mounted on terminal units at the factory.

1.9 SUBMITTALS AFTER CONTRACT AWARD

- A. The following data/information shall be submitted for approval:
1. Complete sequence of operation.
 2. Control system Cad generated drawings including all pertinent data to provide a functional operating system.
 3. Valve, and damper schedules showing size, configuration, capacity and location of all equipment.
 4. Data sheets for all hardware and software control components.
 5. A description of the installation materials including conduit, wire, flex, etc.
 6. Building Management System panel locations.
- B. The Controls Contractor shall provide submitted drawings for the entire control system for review and approval before work shall begin. Included in the submittal drawings shall be a diagram depicting the system architecture complete with a communications riser. Drawings shall include point-to-point wiring diagrams and must show all temperature controls, start-stop arrangement for each piece of equipment, equipment interlocks, wiring terminal numbers and any special connection information required for properly controlling the mechanical equipment. The submittal shall include a bill of material reference list as well as equipment sequences of operation.
- C. The submittals shall include a specification compliance analysis for review and approval before work shall begin. The compliance document shall address each paragraph of this specification by indicating COMPLY, EXCEED, or EXCEPTION. Do not indicate COMPLY unless the proposed system exactly meets the paragraph requirement. If EXCEED or EXCEPTION is indicated, then provide a clear and concise explanation of the variance from the specifications and the net effect this would have on the specified system performance.
- D. Wiring diagrams shall include internal wiring of all electrical control devices.
- E. Submit completed computer graphics for all the equipment and building floor plans minimum floors prior to scheduled completion of the project for approval.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The Building Management System (BMS) shall provide an easy to use interface for monitoring and managing the building. The Building Management System shall provide the necessary Hardware, Software, and Network Communication abilities to provide Scheduling, Monitoring,

Trending, Historical Storage, and Alarm Functions for the HVAC equipment and systems as described in this specification. Control capabilities shall include: Time of Day scheduling, Direct Digital Control, Custom Control, Boolean Logic, Optimum Start/Stop, Duty Cycling, Electrical Demand Control, Temperature Control, After Hours Override, Reports and Logs, Trend Prints, Remote Communications, Alarm Logging, Run Time and Maintenance, and Expanded Informational Messages.

- B. The BMS shall utilize either BACnet or LonWorks open protocol.
- C. The BMS shall be fully accessible via secure internet connection. All required software and/or access to be provided to Engineer for use in troubleshooting.
- D. The Building Management system shall be designed to allow full Operator operation with a minimum of training. It shall have an on-screen "Help" Operator tutorial.
- E. Specified application programs shall be engineered, programmed and pre-tested prior to site installation. This shall be verified by standard format programming worksheets or flow diagrams included with the submittals.

2.2 BUILDING MANAGEMENT SYSTEM

- A. Each panel memory shall be protected for a minimum of 48 hours in the event of power failure. Internal clock shall continue to run during a power failure so that the system makes the appropriate adjustment to all connected points when power is restored.
- B. When specified or indicated on the point list or where required by the sequence of operation, outputs shall have three position manual override switch (On/Off/Auto), a status light, and shall be selectable for either normally open or closed operation.

2.3 MANUFACTURERS

- A. Acceptable Manufacturers Are:
 - 1. Alerton as installed by local factory authorized office (ATS Rocky Mountain).
 - 2. Andover/EcoStruxure by local factory authorized office (Westover Controls Corporation).
 - 3. Carrier as installed by local factory authorized office (Lohmiller and Company).
 - 4. Delta Controls as installed by local factory authorized office (ATS Rocky Mountain).
 - 5. Distech Controls as installed by MSI.
 - 6. Johnson Controls as installed by local factory office.
 - 7. KMC as installed by local factory authorized office (Long).
 - 8. Reliable Controls as installed by local factory office (Unify Energy Solutions)
 - 9. Schneider Electric as installed by local factory authorized office (Dynamic Controls, Inc.)
 - 10. Siemens as installed by local factory office.
 - 11. Trane as installed by local factory office.

12. Tridium as installed by local factory authorized office (ATS, Long, Dynamic Controls)

Any other manufacturer shall be considered a substitution and may submit for approval after the bid.

2.4 OPERATOR INTERFACE

- A. Local Interface. Furnish one PC based workstation(s). Each of these graphics based workstation(s) shall be able to access all information in the system. These workstation(s) shall reside on the same high-speed LAN as the building controllers. Each workstation shall be able to be custom configured based on the needs of the operator.
- B. Hardware. Each operator workstation and custom programming workstation shall consist of the following:
1. Personal Computer. The CPU shall be a minimum of an Intel Core-i7 and operate at a minimum of 2.8 GHz. A minimum of 4 GB of RAM with expansion to 8 GB, DVD drive, Windows Professional or Enterprise 64-bit Operating System, a minimum 256 GB SSD shall be provided. A three-button mouse and keyboard will also be provided. Furnish all required USB and LAN communication ports or wireless capability for proper system operation. The PC shall have a minimum of a 27" flat panel monitor.
 2. Provide a UPS battery backup comparable to an APC 550 VA desktop backup.
 3. Printers: Each workstation shall have one (1) printer connected from the network or dedicated office printer with USB cable.
- C. Workstation Software
1. Multiple Users: The system shall accommodate simultaneous multiple user operation. Access to the system data should be limited only by operator password. Multiple users shall have access to all valid system data. An operator shall be able to log onto any workstation on the system and have access to all valid data.
 2. Operating System: Furnish a concurrent multi-tasking operating system. The operating system shall also support the use of other common software applications that operate under Microsoft Windows Professional such as Microsoft Office.
 3. System Graphics: The Operator Workstation software shall be graphically oriented. The system shall allow display of up to multiple graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while online. An operator with the proper password level shall be able to add, delete, or change dynamic points on a graphic. Dynamic points shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the point.
 - a. Standard Graphics. Provide graphics for each major piece of equipment in the building. This includes but not limited to, each Chiller, Air Handler, VAV

- Terminal, Fan Coil, Boiler, and Cooling Tower. These standard graphics shall show all points as specified in the points list.
- b. Custom Graphics. The system shall have custom graphics provided for all air handling systems and hydronic systems. Graphics shall also include actual floor plans showing equipment, and sensors. Custom graphic files shall be created with the use of a PC Paint package furnished with the system. The PC Paint package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in industry standard formats such as PCX, TIFF, and GEM. The PC Paint package shall also provide the capability of capturing or converting graphics from other programs such as Designer, or AutoCad.
 - c. Graphics Library. Furnish a complete library of common HVAC equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library shall also include symbols for other equipment including fans, pumps, valves, piping, and ductwork. The library shall be furnished in a file format compatible with the PC Paint Program.
 - d. Photo Quality Input. The system shall be able to accommodate high resolution digitized photographs. These shall be scanned in from photographs or 35 MM slides. The owner shall be able to edit the photo quality graphics using the furnished PC Paint Program.
4. Workstation Applications. The workstation shall serve as the primary area of the system for operator interface and off-line storage of system information. The workstation shall also serve as the bridge to other building systems. Provide the following applications at the workstation.
- a. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to save the database from any system panel. The operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
 - b. System Configuration. The workstation software shall provide a simple to use graphical method of configuring the system. As elements are located on the site they shall be displayed on a graphical representation of the system. This shall be flexible to allow for future system changes or additions.
 - c. Online Help. Provide a context sensitive, online help system to assist the operator in operation and editing of the system. Online help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
 - d. Security. Each operator shall be required to log on to the system with a username and a password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application, editor, and object (i.e. Operator One can view and change all airside data but only view chiller plant data, operator two can only acknowledge alarms and not view or change system data etc.) Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto

- logoff time shall be set per operator password. All system security data shall be stored in an encrypted format in the building management panels.
- e. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, LAN connections, building management panels and controllers. The failure of any device shall be annunciated to the operator.
 - f. Trend Logs. Each object in the system shall automatically be trend logged. This trend shall be stored for a minimum of 24 hours. The operator shall be able to view this trend on demand.
 - g. Event Log. The operator shall be able to view all systems alarms and change of states. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.
 - h. Point Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object and property in the system. These statuses shall be available by menu on graphics or through custom programs.
 - i. Clock Synchronization. The real-time clocks in all building control panels and workstations shall be synchronized on command of an operator. The system shall also be able to automatically sequence all system clocks, daily from any operator designated device in the system. The system shall automatically adjust for daylight savings and standard time if applicable.
5. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, states and reactions for each object in the system.
- a. Binary Alarms. Each binary object shall be set to alarm based on the operator specified state. Provide the capability to automatically and manually disable alarming.
 - b. Analog Alarms. Each analog object shall have both high and low alarm limits as well as high and low "early warning" limits. Provide separate sets of limits for both occupied and unoccupied (on/off) conditions. Alarming must be able to be automatically or manually disabled.
 - c. Alarm Reactions. The operator shall be able to determine what action if any is to be taken, by object, during an alarm. Actions shall include logging, printing, starting programs, displaying messages, providing audible annunciation or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day. The system shall provide multiple levels of alarm priority.
6. Workstation Applications Editors. Each PC workstation shall support editing of all system applications. Provide graphically based editors for each application at the PC workstation. The applications shall be downloaded and executed at one or more of the building management panels.
- a. Application Specific Controller. Provide a full-page editor for each application specific controller. This shall allow the operator to view and change the configuration, name, control parameters and set points for each device.

b. Scheduling.

- 1) A complete graphically based editor for the scheduling application shall be provided at each workstation. Provide an easy to use method of selecting the desired schedule and month.
- 2) This shall consist of graphically represented daily schedules and holidays.
- 3) Provide the capability for seasonal schedules that will be automatically executed during user defined periods. This shall enable the operator to have a group of equipment in discrete "Summer" and "Winter" schedules. Each seasonal schedule shall only be active during the operator specified time periods. The schedule shall be available for viewing and editing even when not active. The operator viewing a schedule shall be able to see graphically whether the schedule is active or inactive for up to a year in advance.
- 4) An operator with proper password level shall be able to modify the schedule. Schedules shall be able to be easily copied between objects and/or dates.

7. Custom Programming Language. Provide the capability to perform custom applications. The custom programming editor shall be accessible from all workstations. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. Systems that require the operator interface be shut down to edit and compile programs shall include an additional Custom Programming Workstation. This workstation shall be identical to the operator's workstation in section 2.04.B.

The Program editor shall allow for creation, editing, troubleshooting, and simulation of custom programs. The editor shall check for proper programming context, use, spelling, and format. The custom programming editor shall also compile the program and be able to upload and download to the building management panel. All custom routines shall be executed at the building management panel.

8. Alarm Annunciation.

- a. Upon the incidence of an alarm, an alarm window shall be displayed showing the point in alarm, the time and date of the alarm and a user-selected predefined alarm message (and optionally printed to a user defined printer, printers and/or VT-100 or dumb terminal devices). Alarms shall be displayed regardless of the application in use including any non-DDC system DOS or Windows applications. The program shall display the current unacknowledged and acknowledged alarms. The user shall be able to selectively enable or disable a reminder in the event there are unacknowledged alarms. This reminder shall be both visual and audible. The user shall be able to record their own reminder messages and select the frequency at which they will play.
- b. Acknowledgement of alarms shall be from the alarm "pop-up" and/or from a separate alarm summary. Acknowledgment shall be by a specific event, date range, class, or specific alarm definition and condition. Upon acknowledging the alarm, the name of the operator acknowledging the alarm and the time and date will be

associated with the acknowledgement, this data will be stored to the alarm history file and printed to the chosen printers or terminal devices.

- c. The system shall allow automatic or manual display of associated dynamic graphic screens and trend charts shall be provided for each alarm.
- d. Upon exiting the alarm handling mode, the user shall be placed back to the application in use at the time of alarm/exception occurrence.
- e. A current alarm screen shall be provided which will dynamically display only alarms that are currently in alarm. As alarms are return-to-normal from their respective alarm states the current alarm screen shall be dynamically updated to reflect the change.

9. Trend Management

- a. The program shall automatically perform time based periodic collection of real time point data and subsequently store it to the systems hard disk. There shall be local and remote modes of operation. Local collection shall allow the program to directly query the controllers for individual point samples. Remote collection shall mean the controllers collect and store trend data on individual points and then release the entire trend table(s) upon a request from the computer workstation.
- b. Storage and manipulation of sample points shall only be limited by disk space. Sampling rates shall be user selectable from instantaneous (once a second or less) to once a week. Collection of data shall be user selectable to start and stop on specific times and dates.
- c. Charting of the trend data shall be an integral part of the trend management program. Third party graphing packages such as Excel shall not be required to implement this program. Multiple points shall be chartable. Multiple X/Y charts may be run simultaneously displaying either real time data (instantaneous) or historical. Y scaling shall be either automatic or user selectable for any chart displayed, each chart may have different scaling. X scales shall be user selectable allowing for display of data over the wide range of times and dates. Multiple years of data shall be allowed. The chart display shall be capable of displaying a window of time as short as 15 seconds. Average, high and low values shall be displayed for selected point.

10. Reporting

- a. The report section shall be the gateway to the database for all data collected and shall provide an easy means of reporting and information management.
- b. The report generator shall be an integral part of the system. Offline third-party packages (such as Excel) for report manipulation shall not be required to implement this program.
- c. Reports on historical trend data shall allow for daily, weekly, monthly and yearly reporting. These reports shall be completely flexible on the data items to be reported on. The user shall be able to select from a list of predefined reports or selected data items on-the-fly. The selection of data item shall not be restricted by panel source. Reports shall have multiple columns and be infinite in length. Reports must be capable of reporting on data that has been collected at varying

time intervals. Report generator shall allow an operator to easily and quickly define the contents of a report as well as define a print time and date if so desired. Information contained in the reports shall be derived from alarm history, system database, trend data and timed overrides.

- d. The operator shall be able to compile reports by user, department, time and data period, point or points.

11. Multi-tasking

- a. The system shall be capable of true multi-tasking capabilities. The user shall be able to use other non-related programs in the system while still running all DDC system application with no interruptions. This shall include the use of real time data in other applications. This feature shall allow spread sheet programs to gather data from the system dynamically while running a dynamically updated graphic screen. The system shall have the ability to allow the passing of data freely to MS Windows application, which incorporate the use of Dynamic Data Exchange.

2.5 SYSTEM PERFORMANCE

- A. The system shall consist of Operator Workstation, Building Management Panels, and Application Specific Controllers. All elements of the system shall be designed for standalone operation. Control shall always occur at the lowest level of the system. Communication between the building management panels and workstations shall be over a high-speed communications buss. All nodes on this LAN shall be peers. The operator shall not have to know the panel identifier or location to view or control an object. Application Specific Controllers shall be constantly scanned by the building management panels to update point information and alarm information.

2.6 SYSTEM APPLICATION CONTROLLER SOFTWARE

- A. System Security: User access shall be secured using individual security passwords and usernames.
- B. Passwords shall restrict the user to only the object, applications and system functions as assigned by the system manager.

2.7 SYSTEM SOFTWARE

- A. Furnish the following applications for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator workstation.
1. Scheduling: Provide the capability to schedule each object or group of objects in the system. Each scheduler shall consist of the following:
 - a. Weekly Schedule: Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop, and night economizer. Each scheduler may consist of up to 10 events. When a group of objects are scheduled together, provide the capability to adjust the start and stop times for each number.
 - b. Exception Schedules: Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to one year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.
 - c. Holiday Schedules: Provide the capability for the operator to define up to 30 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
 2. Optimal Start/Stop: The scheduling application outlined above shall support an optimal start/stop algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. Provide an early start limit in minutes to prevent the system from starting too early.
 3. System Coordination: Provide a standard application for the proper coordination of equipment.
 4. Alarm Reporting.
 5. Trending.
 6. Diagnostics.
 7. Power Fail Recovery.
 8. Reports and Logs.
 9. Chiller Sequencing.

2.8 NETWORK CONTROLLERS

- A. General. Provide an adequate number of Building Management Panels to provide the performance specified above. Each of these panels shall meet the following requirements.
1. The Building Automation System shall be composed of one or more independent stand-alone, microprocessor-based Network Controllers to manage the global strategies describes in Application software section.

2. The Master Controller shall have substantial memory to support its operating system, database, and programming requirements.
 3. The multi-tasking operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 4. Data shall automatically be shared between Master Controllers when they are networked together.
 5. The database and custom programming routines of remote Network Controllers shall be editable from a single operator station.
 6. The Master Controller shall continually check the status of all processor and memory circuits. If a failure is detected, the controller shall:
 - a. Assume a predetermined failure mode.
 - b. Emit an alarm.
 - c. Display card failure identification.
- B. Communications. Each master controller shall reside on an Echelon LonWorks/LonTalk protocol network with data transmission speeds of at least 1.25 MBPS.
- C. Serviceability. The Network Controller should be designed in a modular fashion so that the enclosure may be roughed in prior to the installation of the electronics. Provide diagnostic LEDs for power, communications, and alarms. The controller shall have provisions for expansion and future controller architecture. All wiring connections shall be made to field serviceable terminal strips or to a termination card connected by a ribbon cable.
- D. Memory. The Network Controller shall maintain all BIOS and programming information in EEPROM. The system BIOS shall be easily upgradable for the PC workstation without the need for going out to the panel. System manufacturer shall provide current version software and firmware at the end of the warranty period.

2.9 APPLICATION SPECIFIC CONTROLLERS

- A. Application Specific Controllers shall be stand-alone, microprocessor based Direct Digital Controllers with sufficient EEPROM memory to handle its operating system, database and programming requirements.
- B. The controllers shall be clearly labeled as to controller type, where it is to be installed, and software address (if applicable). The controller shall be fully tested upon installation to ensure that it is properly matched to the equipment it is controlling.
- C. The controller shall communicate with other devices on the communication network and be fully integrated with the other system components.

- D. The hardware shall be suitable for the anticipated ambient conditions.
1. Controllers used outdoors and/or in wet ambient shall be mounted within waterproof enclosures, and shall be rated for operation at -40°F to 155°F.
 2. Controller used in conditioned ambient shall be mounted in dust-proof enclosures, and shall be rated for operation at 32°F to 120°F.
- E. Box Controllers
1. The VAV terminal units shall be individually controlled by a dedicated DDC VAV controller. The DDC VAV controller, damper motor, transducer and transformer (if required) shall be supplied by the BAS contractor.
 - a. To assure proper operation and control, the BAS contractor as part of this bid, shall recalibrate the transducers six (6) months after acceptance of the BMS system to correct any deviations as a result of transducer drift.
 - b. Submit a copy of the recalibration report to the Engineer, Mechanical Contractor, Test, Adjust and Balance Contractor and Owner.
 2. The BMS shall perform the following VAV Terminal unit control strategies and provide the points as listed on the DDC/VAV point list and specified monitoring and diagnostics.
 - a. Grouping: The BAS shall be able to group VAV boxes via keyboard commands. These groups shall make it possible for the operator to send a common command to all boxes in a group to operate in the same mode. A sample of this group report must be provided in the submittal package for approval by Engineer and Owner. BAS shall also compile on a group basis, the following:
 - 1) Current airflow through boxes in group (total).
 - 2) Total ventilation airflow in group (total).
 - b. Operating Mode: The BMS shall place the box in either the occupied or unoccupied mode based on an operator adjustable time schedule.
 - c. Automatic Recalibration: The system shall automatically recalibrate its air flow sensing and air valve position measurement system at system startup and on a schedule basis.
 - d. Portable interface terminal: The VAV box shall have a communications port on the space sensor for use with a handheld portable operator's terminal. This portable terminal shall give the operator the capability to interrogate and edit DDC/VAV box parameters. Portable interface terminal shall also have the capability to interrogate and edit DDC/VAV box parameters from a central controller.
 - e. Terminal Unit Status Reports: For each terminal unit, the BMS shall provide an operating status summary of all unit sensed values (CFM, etc.), setpoint and modes.
 - f. Terminal Unit Group Report: For each group of VAV terminal units, the BMS shall report the group mode and airflow. The report shall also display for each

terminal unit in the group, the present temperature control setpoints and the current zone temperature.

3. Terminal Box Diagnostics:

- a. If flow measuring system fails, unit shall automatically convert to a pressure dependent, damper position-based algorithm. Diagnostic message shall be displayed upon operator inquiry.
- b. If communications are lost, controller shall continue to operate in current mode of operation. All setpoints shall be retained in nonvolatile memory. If communications are not restored within 15 minutes, unit shall automatically initiate a reset-recalibrate.

2.10 CUSTOM APPLICATION CONTROLLERS

- A. The Custom Application Controllers shall provide stand-alone control and require no additional system components for complete operation. It shall have sufficient EEPROM memory to support its operation system, database, and programming requirements. Custom application controllers shall meet the requirements of 2.06 Master Control Panels except they shall reside on a communications network operating at a minimum of 38,400 KBPS.
- B. All programming required for operation shall be memory resident and shall be retained in permanent memory.
- C. The Custom Application Controller shall be configured such that the Portable Operators Terminal can be plugged directly into it or within sight for programming, editing, and other operator functions. Custom application controllers shall also be programmable from the operator workstation.
- D. Controller hardware shall be suitable for the anticipated ambient conditions.
- E. Controllers used outdoors and/or in wet ambient shall be mounted within waterproof enclosures and shall be rated for operation at -40°F to 155°F.
- F. Controller used in conditioned ambient shall be mounted in dust-proof enclosures, and shall be rated for operation at 32°F to 120°F.

2.11 INPUT/OUTPUT INTERFACE

- A. Hardwired inputs and outputs may tie into the system through Master Control Panel, Custom Application, or Application Specific Controllers. Any critical points requiring immediate reaction shall be tied directly into the controller hosting the control software algorithm for the critical function.

- B. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a sufficient wetting current to be compatible with commonly available control devices.
- C. All status points shown on the point list shall be positive proof differential pressure or current sensing binary switches.
- D. Analog inputs shall allow the monitoring of low-voltage, current, or resistance signals and shall have a minimum resolution of 0.1% of the sensing range. Analog inputs shall be compatible with, and field configurable to commonly available sensing devices.
- E. Binary outputs shall provide a continuous low-voltage signal for on/off control of remote devices. Where specified in the sequence of operations or indicated on the points list, binary outputs shall have 3-position (on/off/auto) override switches, status lights, and shall be selectable for either normally open or normally closed position.
- F. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC, 0 to 20 VDC or a 4 to 20 milliampere signal as required to provide proper control of the output device. Systems that utilize a pulse width modulating output (PWM) shall include a position feedback AI for each output.
- G. System architecture shall allow for point expansion in one of the following ways:
 - 1. The addition of input/output cards to an existing System Application Controller.
 - 2. An additional panel and/or controller may be used to expand point capacity.
 - 3. Ten (10) percent expansion capacity for all point typed in all DDC panels.

2.12 IDENTIFICATION

- A. Engraved Labels
 - 1. Material: Melamine plastic laminate.
 - 2. Thickness: 1/16".
 - 3. Color
 - a. Surface: White.
 - b. Core: Black (letter color).
 - 4. Fastenings: Any of the following:
 - a. Screws.
 - b. Rivets.
 - c. Permanent adhesive.
 - 5. Lettering: Coordinate with shop drawings.

2.13 DUCT SMOKE DETECTORS

- A. Duct smoke detectors shall be provided and wired in accordance with Section 23 05 01.

2.14 PIPING

- A. Exposed Air Piping: Hard copper tubing or flame-resistant plenum rated polyethylene tubing in metal conduit or trough.
- B. Concealed Air Piping:
 - 1. Soft copper tubing, or flame-resistant plenum rated polyethylene tubing, properly supported.
 - 2. Do not use polyethylene tubing near sources of heat.

2.15 BMS/ATC CONTROL WIRING

- A. General: 18 AWG Twisted pair cable shield wire shall be provided if required by system manufacturer.
- B. Provide for all input and all analog output wiring.
- C. Tinned copper conductors.
- D. Do not run input/output wires together in the same conduit or wire bundle with 120V power wiring.
- E. Sensor tubing shall not be installed in conduit with any wiring conductors.
- F. Refer to Part 3 below for locations where conduit is required. All rigid conduit shall comply with Division 26 requirements.

2.16 AUXILIARY CONTROL DEVICES

- A. Dampers:
 - 1. The Building Automation System supplier shall provide all automatic control dampers not specified to be supplied integral to the HVAC equipment.
 - 2. Dampers shall be low leakage or high velocity low leakage air foil as specified in the sequence of operation or in the equipment specifications and schedules. All proportional dampers shall be opposed blade type, except mixing dampers shall be parallel type. Two position dampers may be opposed or parallel blade type.
 - 3. Damper frames and blades shall be galvanized steel and a minimum of 16 gauge. Blade width shall not exceed 8 inches. Dampers and seals shall be suitable for temperature ranges of -50°F to 250°F.

4. Blades: 14-gauge, or 16-gauge air foil shaped, double, galvanized steel or extruded aluminum.
5. Bearings: Nylon or oil impregnated.
6. Axles: Welded, hexagonal or pin lock, or with other approved method to prevent blade rotating on axle.
7. Hardware: Zinc plated steel or aluminum.
8. Standard Low Leakage Dampers:
 - a. Standard low leakage dampers shall be provided to conserve energy. Dampers shall be equipped with neoprene edge seals and compressible metal jamb seals. Leakage shall not exceed 10 CFM/Sq. Ft. at 4" W.G. differential.
 - b. Standard Low Leakage dampers shall be Ruskin, Model CD36 or equivalent.
9. High Velocity Low Leakage Dampers:
 - a. Where specifically called out as "LOW LEAKAGE", provide the following:
 - 1) Field replaceable edge and end seals with be installed along the top, bottom, and side of the frame and each blade. Seals and bearings shall be suitable for temperature ranges from -40°F to 200°F. Leakage shall not exceed 6 CFM/Sq. Ft. at 4" W.G. differential.
 - 2) High Velocity Low Leakage dampers shall be Ruskin, Model CD60 or equivalent.
10. Provide low leakage dampers in the following locations:
 - a. Outside air dampers.
 - b. Motorized backdraft dampers.
 - c. Motorized intake dampers.

2.17 CONTROL VALVES

- A. Provide control valves of the type, body material and pressure class as determined by manufacturer, based on operating requirements and maximum pressure and temperature in the piping system.
- B. Equip control valves with actuators of proper close-off rating.
- C. Modulating control valves shall have equal percentage or linear flow characteristics.
- D. Valve bodies shall be 2-way normally open or closed, or 3-way mixing as specified. Valve bodies 2" and smaller shall be bronze, screwed type and 2½" and larger shall be iron, flanged and rated at 240°F 125 psig except where otherwise noted.
- E. Valves shall have stainless-steel stems and allow for servicing including packing, stem, and disk replacement, and offer a 5-year warranty on parts and labor.

- F. Size valves for 50% coil pressure drop (minimum 3', maximum 12' pressure drop).
- G. Two-position, two-way control valves shall have quick opening characteristics.
- H. Three-way valves shown in mixing application shall have a single, double faced disk.
- I. Three-way valves shown in diverting application shall have two separate disks on a common shaft.

2.18 VALVE ACTUATORS: (ELECTRIC)

- A. Valve actuators shall be electronic low voltage (24VAC), and properly selected for the valve body and service. Belimo or equivalent.
- B. Actuators shall be fully proportioning (if modulating) and be spring return for normally open or normally closed operation as called out in the sequence of operations.
- C. Provide a handwheel or manual positioner mounted adjacent to valve to allow manual positioning of valve in the absence of power.
- D. Tri-state floating control non-spring return actuators are acceptable for terminal reheat applications for sizes less than one inch.
- E. Actuators that rely on heating a medium are not acceptable.

2.19 BUTTERFLY VALVES

Butterfly valves used for automatic control shall be lug type rated for 125 psi non-shock water service to 180°F.

- A. Valve body shall be ductile iron with B-Nitrite (BUNA N) or EPDM molded seat and seals.
- B. Disc material shall be cast bronze or aluminum-bronze with ASTM A-492 Type 416SS stainless-steel stem and fittings.
- C. Valves shall be tight close off suitable for end of the line service.
- D. Butterfly valves used for two position control shall be line size. Valves used for modulating control shall be sized for a minimum 5 psig differential pressure at full flow.
- E. Three-way valve mixing or diverting configurations shall have factory provided linkage kits specifically manufactured for the piping arrangement and actuator used. Keystone or approved equivalent.

2.20 SPACE SENSORS (OCCUPANT INTERFACE)

- A. Space sensors shall be equipped with setpoint adjustment and override switch. Space sensor shall have a portable service tool jack.
- B. All space sensors shall include integral temperature sensor, humidity sensor and CO2 sensor. Space temperature shall be adjustable within adjustable range through central BMS. Humidity and CO2 shall be read to BMS for monitoring and control. Reference following sections for individual sensor requirements.
- C. All space sensors located in restrooms, corridors, gymnasiums, cafeterias or similar use areas shall be provided with vented, protective and lockable plastic cover.

2.21 TEMPERATURE SENSORS

- A. Temperature sensors shall be Resistance Temperature Detector (RTD) or Thermistor as dictated by the requirements of this specification.
- B. Duct sensors shall be rigid or averaging as specified in the sequence of operations. Averaging sensors shall be a minimum of 5 feet in length.
- C. Immersion sensors shall be provided with a separable stainless-steel or brass well to match pipe material.
- D. Space sensors shall be equipped with setpoint adjustment and/or override switch as specified on the plans or in the sequence of operations. Space sensor shall have a portable service tool jack.
- E. Accuracies shall be $\pm 1^{\circ}\text{F}$ for standard applications. Where high accuracy is required, accuracies shall be $\pm .2^{\circ}\text{F}$.
- F. Duct-mounted averaging sensors shall utilize a sensing element incorporated in a copper capillary with a minimum length of 20 feet. The sensor shall be installed according to manufacturer's recommendation and looped and fastened at a minimum of every 36 inches.
- G. Sunshields shall be provided for outside air sensors.

2.22 HUMIDITY SENSORS

- A. Humidity sensors shall be capacitance or bulk polymer resistance type.
- B. Duct and room sensors shall have a sensing range of 20 to 80% with accuracy of $\pm 3\%$ R.H. Duct sensors shall be provided with a sampling chamber.
- C. Outdoor air humidity sensors shall have a sensing range of 20 to 95% RH. They shall be suitable for ambient conditions of -40°F to 170°F .

2.23 DIFFERENTIAL PRESSURE AND CURRENT SWITCHES

- A. Differential Pressure Switches shall be furnished as indicated for status purposes in air and water applications. Provide single pole double throw switch with fully adjustable differential pressure settings.
- B. Sensing range shall be suitable for the application with accuracy of +/-2% of range and repeatability of +/-0.5 % of range. Sensor shall be capable of withstanding up to 150% of rated pressure without damage.
- C. Current switches shall be provided for status indications on variable air flow fans and variable pump speed applications. These switches shall be capable of installation and replacement without removing power wiring.

2.24 CARBON DIOXIDE (CO₂) DETECTION SENSOR

- A. Provide carbon dioxide gas detection sensors as indicated on drawings. Carbon dioxide detection sensors shall meet, at minimum, the following requirements:
 - 1. Negligible temperature and humidity effect on accuracy.
 - 2. 4-20 mA transducer interface with the BMS proportional to 0 to 2,000 ppm of carbon dioxide concentration.
 - 3. 24 VAC or VDC @ 400 mA max voltage.
 - 4. No maintenance or period sensor replacement needed.
 - 5. Accuracy- 5% of reading or 100 ppm, whichever is greater.
 - 6. Operating temperature of 32° F to 122° F.
 - 7. Aspirating box.
 - 8. Outside air sensor shall be environmentally protected.
- B. If it meets the above requirements, provide Ventostat, Model T8100D (with display) or approved equal.

2.25 CARBON MONOXIDE (CO) DETECTION SENSOR

- A. Provide carbon monoxide gas detection sensors as indicated on drawings. Carbon monoxide detection sensors shall meet, at minimum, the following requirements:
 - 1. Negligible temperature and humidity effect on accuracy.
 - 2. 4-20 mA transducer interface with the BMS proportional to 0 to 250 ppm of carbon monoxide concentration.
 - 3. 24 VAC or VDC @ 400 mA max voltage.
 - 4. No maintenance or period sensor replacement needed.
 - 5. Accuracy 2% of reading or 5 ppm, whichever is greater.
 - 6. Operating temperature of 32° F to 122° F.
 - 7. Aspirating box.

8. Outside air sensor shall be environmentally protected.
9. Activate purge fan mode at 25 ppm. Activate full alarm mode at 200 ppm.

2.26 STATIC PRESSURE SENSORS

- A. Static pressure sensors may be absolute or differential pressure type depending on installation requirements below.
- B. For differential pressure type sensors, maximum poly tubing length shall not exceed 100'. Minimum poly tubing diameter shall be 3/8". Above 100' length, provide 2" PVC main with maximum 100' connection length to each indoor sensor or outdoor reference sensor. All PVC shall be located outside of return air plenums or provided with plenum rated insulation.
- C. Absolute pressure type sensors shall measure absolute pressure at outdoor and indoor locations, with signal communicated and differential pressure calculated via the BMS.
- D. The sensor range shall be closely matched to the system static pressure, - .5 to .5 inches, -1 to 1 inches, 0 to 2.5 inches.
- E. Sensor accuracy shall be plus or minus 5% of the sensing range, and repeatability of 2% of sensor range.

PART 3 - EXECUTION

3.1 FUNCTION

- A. Provide all components necessary to achieve the Sequences of Operation listed in Part IV and any additional industry standard functions normally required of a first class BMS/ATC installation.
- B. This division shall provide a project manager who shall, as a part of his duties, be responsible for the following activities:
 1. Coordination between this Contractor and all other trades, Owner, local authorities and the design team.
 2. Scheduling of manpower, material delivery, equipment installation and checkout.
 3. Maintenance of construction records such as project scheduling, manpower planning, and as-built drawings for project coordination and as-built drawings.

3.2 INSTALLATION METHODS

- A. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 26 sections of these specifications.

- B. The term “control wiring” is defined to include providing of wire, conduit, and miscellaneous materials as required for mounting and connecting electric or electronic control devices.
- C. Control Wiring:
1. Number-code or color-code conductors appropriately for future identification and servicing of control system.
 2. All line voltage power wiring required because of substitution of low-voltage power wiring equipment specified in this division, shall be provided by this division.
 3. Comply with the applicable requirements of Division 26 for the installation of electrical wiring incidental to the temperature control system.
 4. Comply with the applicable requirements of National Electrical Code and International Building Code for the installation of electrical wiring incidental to the temperature control system.
 5. Control wiring shall be run in conduit where located within walls, above drywall ceilings, in other inaccessible areas, or in areas subject to damage (i.e., below 8' in mechanical rooms). Conduit to meet requirements of Division 26. Wiring above lay-in acoustical ceilings may be run loose and not in conduit. Where not in rigid conduit, bundle wiring neatly and support with J-hooks form structure.
 6. Conduit shall be run parallel to building lines properly supported and sized at a maximum of 40% fill. In no cases shall field installed conduit smaller than 1/2" trade size be allowed.
 7. Where conductors are not in conduit (as allowed through an owner accepted substation request) cable rated for use in return air plenums shall be used in all locations.
 8. BMS/ATC division shall provide all control transformers and all control wiring (including low-voltage actuator power wiring). This division shall also provide power wiring from the control circuits to the transformer locations and all other temperature control devices requiring power wiring. Division 26 shall furnish appropriate control circuits (both normal and emergency) in suitable panelboards located throughout the project.
 9. BMS/ATC division shall provide UL listed surge protectors for all control circuits upstream of control transformers.
- D. Equipment installed under other divisions of the specifications:
1. Furnish dampers, valves, thermostat wells, flow switches and other equipment to Installers at proper time.
 2. Provide installation instructions.
- E. Adjust low-leakage dampers so all gaskets and seals are properly compressed.
- F. Provide outside air and relative humidity sensors at each outside air intake louvers for air handlers.
- G. Install occupant controls (thermostats, etc.) at 48" A.F.F. or as directed by Architect.

3.3 IDENTIFICATION

- A. Devices Inside Panels: Either of the following:
 - 1. Engraved labels.
 - 2. Lettered in permanent ink with felt tip marker.
- B. Exposed Devices: Engraved labels.
- C. Location: On the body of the device or on the surface to which it is mounted.
 - 1. Do not put identification on removable covers.
- D. Label each remotely-mounted control panel as to the device it controls.

3.4 OPERATING AMBIENT CONDITIONS

- A. Electronic controls mounted in unconditioned space shall be rated for ambient operating conditions from -40°F to 155°F. Controls not meeting these limits shall be mounted in an accessible location within conditioned space.
- B. Where controllers and other components are located in outdoor or unconditioned spaces provide cabinets with ventilation and/or electronic heaters where required to maintain temperature and moisture levels required for proper operation.

3.5 ACCESSIBILITY

- A. Where enclosures for system components are located in an area that is subject to unauthorized access (i.e., parking garage, service corridor, storage room, etc.), provide lockable tamper-proof enclosure to prevent unauthorized access. Enclosure shall be ventilated as required for proper operation of components.

3.6 OWNER TRAINING

- A. The BAS/ATC contractor shall provide 4 copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the temperature control and Building Automation System supplied. This contractor shall instruct the owner's designated representatives in these procedures during the startup and test period. The owner training shall consist of a minimum of three (3) 8-hour instruction periods scheduled by the owner over the first 12 months of system operation. The training shall be scheduled during normal working hours.
- B. Follow up training shall be provided under this Division for two (2) eight-hour instruction periods at six months and twelve months after building acceptance.

- C. Provide minimum 40 classroom hours of factory training in programming and use of the BMS/ATC system for each of two people (designated by Owner). Provide room and board for trainee's class during this period if factory is located more than 30 miles from the project. Provide this training no more than six months, and no less than eighteen months after building acceptance.

3.7 CALIBRATION AND ADJUSTMENTS

- A. After completion of the installation, perform final calibrations and adjustments of the equipment provided under this contract and supply services incidental to the proper performance of the ATC and BAS system under warranty below.
- B. Provide operating software to Engineer for remote connection and troubleshooting.

3.8 OPERATION BY OWNER

- A. Owner may require operation of part of the system prior to final acceptance. Operation is not to be construed as acceptance of work.

3.9 ACCEPTANCE PROCEDURE

- A. General: The system installation shall be complete and tested for proper operation prior to acceptance testing for the Owner's authorized representative.
- B. Upon completion of the calibration, Contractor shall startup the system and perform all necessary testing and run diagnostic tests to ensure proper operation. Installer shall be responsible for generating all software and entering all database necessary to perform the sequence of control and specified software routines. An acceptance test in the presence of the Owner's representative or Architect shall be performed.
 - 1. If more than two of the first 10 devices tested, or more than 10% of the first 20 or more devices tested, fail to operate properly, the test shall be discontinued.
 - 2. Additional testing, after corrections are made, shall be done at the Installer's expense.
- C. A letter shall be submitted to the Architect requesting system acceptance. This letter shall certify all controls are installed and the software programs have been completely exercised for proper equipment operation. Acceptance testing will commence at a mutually agreeable time within ten (10) calendar days of request. When the field test procedures have been demonstrated to the Owner's representative, the system will be accepted. The warranty period will start at this time.

- D. Field Equipment Test Procedures: DDC Zone and Local Controllers shall be demonstrated via a functional end-to-end test as follows:
1. All output channels shall be commanded (on/off, stop/start, adjust, etc.) and their operations verified.
 2. All analog input channels shall be verified for proper operation.
 3. All digital input channels shall be verified by changing the state of the field device and observing the appropriate change of displayed value.
 4. If a point should fail testing, perform necessary repair action and retest failed point and all interlocked points.
 5. Automatic control operation shall be verified by introducing an error into the system and observing the proper corrective system response.
 6. Selected time and setpoint schedules shall be verified by changing the schedule and observing the correct response on the controlled outputs.
- E. Workstation Test Procedures: The System Workstation test procedures shall be as follows:
1. Communication with each DDC Zone and Local Controller shall be demonstrated.
 2. Operator commands will be explained and demonstrated.
 3. Control sequences shall be demonstrated for proper operation.
 4. All available system reports and logs shall be demonstrated at the System Workstation.
 5. Correct system start-up and shutdown procedures shall be demonstrated.
 6. All controllers shall be demonstrated to operate in standalone mode.
- F. Acceptance Test of Mechanical Systems
1. Perform at least two (2) operational tests of the entire mechanical system.
 2. Give each element of the system an operating test of not less than 48 hours' duration to demonstrate to the satisfaction of the Architect that the control system is functioning properly and that the system is capable of producing the required environmental conditions. During this test, operate the system entirely on automatic control and take periodic readings of the inside and outside wet and dry bulb temperatures. Obtain wet and dry bulb temperatures with a recording thermometer-hygrometer. Conduct tests with outside temperature and humidity conditions as near design conditions as practical.
 3. Winter acceptance test shall be conducted when outside temperatures are at or near 10°F, summer acceptance test shall be conducted when outside temperatures are at or near 80°F db.
 4. Conduct tests during summer and winter outdoor temperature extremes as specified above. Notify Owner seven (7) days in advance of proposed tests.
 5. Record temperature and humidity at an exterior and interior location for each system as designated by the Engineer at least once every hour for 48 hours during tests.

6. Submit a report detailing the following:
 - a. Instrument used:
 - 1) Most recent calibration date.
 - b. Date of tests.
 - c. Description of test apparatus locations and methods.
 - d. Results of tests.
 - e. Any abnormal usage of the building or abnormal system characteristics observed during the course of the test.

3.10 RECORD DOCUMENTS

- A. Electronic Media As-Built Documentation: After a successful acceptance demonstration, the Contractor shall submit as-built drawings of the completed project for final approval. After receiving final approval, supply complete 11X17 hard copy as-built drawing sets, together with diskettes to the owner. The number of hard copies shall be electronic media equal to the number of O&M manuals (Re: Division 1).
- B. Operation and Maintenance Manuals: Submit Operation and Maintenance manuals (Re: Division 1). Include the following in each manual:
 1. BMS/ATC information for insertion into the Manufacturer's catalog data and specifications on all sensors, transmitters, controllers, control valves, damper actuators, gauges, indicators, terminals, and any miscellaneous components used in the system.
 2. An Operator's Manual which will include detailed instructions for all operations of the system.
 3. An Operator's Reference Table listing the addresses of all connected input points and output points. Settings shall be shown where applicable.
 4. A Programmer's Manual which will include all information necessary to perform programming functions.
 5. A language manual which will include a detailed description of the language used and all routines used by the system.
 6. Flow charts of the control software programs utilized in the Temperature Control System.
 7. Flow charts of the custom software programs utilized in the Temperature Control System.
 8. Complete program listing file and parameter listing file for all programs.
 9. A copy of the warranty.
 10. Operating and maintenance cautions and instructions.
 11. Recommended spare parts list.
 12. Twelve (12) hour service phone number and point of contact.

3.11 WARRANTY

- A. All BAS/ATC devices and installation shall be warranted to be free from defects in workmanship and material for a period of one year from the date of job acceptance by the owner. Any equipment, software, or labor found to be defective during this period shall be repaired or replaced without expense to the owner. Factory authorized warranty service shall be available within 50 miles of jobsite.

END OF SECTION 23 09 00

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section covers water piping carrying water at 200°F or less, used in the following systems:
1. Heating system
 2. Cooling system
 3. Condensate drain system

1.2 SUBMITTALS

- A. Detailed piping shop drawings, which include sizes, layouts, and materials, must be properly submitted. Any piping installed without prior written approval by the engineer of record shall be replaced at the expense of the contractor.
- B. Submit manufacturer's product data on the following:
1. Strainers
 2. Expansion tanks
 3. Air purgers
 4. Air vents
 5. Pressure reducing fill valves
 6. Pressure temperature taps
 7. Balancing valves
 8. Thermometers
 9. Flow indicating devices
 10. Pot feeders
 11. Automatic flow control valves
 12. Relief valves
 13. Glycol

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Size 2" and Smaller: Any of the following:
 - 1. Steel pipe, Schedule 40 with 125-lb. cast iron threaded fittings (ASTM A-53).
 - 2. Copper tube, hard temper, Type L with wrought copper fittings.
 - a. Solder for copper tube joints:
 - 1) 30 psig to 175 psig: 95-5 tin antimony.
 - 2) Above 175 psig: Brazed joints.
 - b. Grooved Copper
- B. Size 2½" and Larger: Steel pipe (ASTM A-53), standard schedule, with any of the following fittings:
 - 1. Black steel standard weight butt weld.
 - 2. 125-lb cast iron flanged.
 - 3. Malleable or ductile iron grooved pipe fittings, designed for roll or cut grooved joint (grooved piping 24" and larger to be Schedule 40).

2.2 PREINSULATED/BURIED PIPE

- A. Pipe Materials: Pipe and tube of type, pressure and temperature ratings, capacities, joint type, grade, size and weight indicated for each service.
- B. Pipe/Tube Fittings: Factory-fabricated fittings of type, materials, grade, class, and pressure rating indicated for each service and pipe size.
- C. A preinsulated piping system consists of carrier pipe, insulation, protective jacket, connectors, supports and appropriate fittings.
- D. All straight sections, fittings, anchors and other accessories shall be factory fabricated to job dimensions and designed to minimize the number of field welds. One square cut, plain end for field cutting and beveling is allowed per straight run of pipe. Other ends shall be factory square cut and factory beveled such that the field welds have the capability of being welded to pass x-ray testing.
- E. The system design shall be in strict conformance with ASME/ANSI B31.1, latest edition, and stamped by a registered professional engineer.

F. Manufacturers:

1. Perma-Pipe
2. Thermal Pipe System
3. Thermacor

G. Accessories:

1. End seals, fittings and anchors shall be designed and factory fabricated to prevent the ingress of moisture into the system during shipping, outdoor storage, installation and operation. End caps on the ends of the service pipe are required to prevent debris from entering the pipe for the period of time up until installation.

H. Protective Jacket:

1. All straight sections of the factory preinsulated piping system shall be jacketed with a High Density Polyethylene jacket conforming to ASTM D1248. PVC jackets shall not be allowed.
2. All HDPE jacketing material shall have minimum wall thickness as specified below. The wall thickness shall not be less than indicated in these specifications.

<u>Jacket O.D.</u>	<u>Jacket Thickness</u>
O.D. \leq 12"	0.125"
12", O.D. \leq 24"	0.150"
O.D. 24"	0.175"

3. All fittings of the factory preinsulated piping system shall be jacketed with the same material used for the straight sections of pipe and prefabricated to minimize field joints. Fittings shall be jacketed using a molded HDPE cover over polyurethane foam. Fittings shall be waterproof from the factory without the use of any type of tape, cellophane (or other non-HDPE plastic) wrap, mastic, glue or hot air welds.

I. Field Joints:

1. All field joints shall be made in straight sections of pipe. Field joints other than at straight sections shall not be acceptable.
2. The method of field joint closure is as follows:
 - a. The field joints are pressure tested and inspected for leaks.
 - b. A split sleeve with holes in the top is placed around the joint area and secured with straps and sealed to the jacket with tape.
 - c. Two-part polyurethane foam is mixed properly and poured into the holes on the top of the split sleeve.
 - d. After the foam insulation has expanded and cured, any excess foam shall be removed.
 - e. An adhesive backed heat shrinkable sleeve is then placed around the field joint area making sure to overlap the sleeve onto the HDPE jacketing by at least 3" on each

- side. This 3" overlap is to be completely on the HDPE and does not include the length of overlap of the split sleeve or tape.
- f. Heat is applied using a rosebud torch to the heat shrinkable sleeve slowly and evenly across the length of the sleeve until the sleeve has drawn tight.
 - g. Any spots that pucker up during the shrinking process shall be covered with a thick-bodied asphaltic mastic (black roofing compound).
 - h. Backfilling of the trench shall not begin until the area has cooled to the touch.
3. The piping systems manufacturer shall furnish all the foam insulation, split sleeves and heat shrinkable jacketing materials for making the field joints. The contractor shall furnish the straps, tape, knives, saws, torch, gas and mastic materials.

2.3 STRAINERS

A. Manufacturers:

- 1. Armstrong
- 2. Gruvlok
- 3. Hoffman
- 4. IMI Flow Design
- 5. Metraflex
- 6. Mueller
- 7. Sarco
- 8. Victaulic

B. Size 2" and Smaller: 250-lb cast iron, threaded.

C. Size 2½" and Larger: 125-lb cast iron, flanged or grooved.

D. Screens:

- 1. Final Screen:
 - a. Material: Type 304 stainless steel.
 - b. Perforations: 0.045" diameter, 233 holes per square inch.
- 2. Roughing Screen:
 - a. Material: Carbon steel.
- 3. Provide roughing screens at all circulation pumps and at any additional strainers upstream of primary plant equipment such as boilers, chillers, etc.

2.4 EXPANSION TANKS

- A. Manufacturers:
 - 1. Amtrol
 - 2. Apollo
 - 3. Armstrong
 - 4. ITT Bell & Gossett
 - 5. John Wood
 - 6. Taco
 - 7. Wessels
- B. Type: Bladder.
- C. Design Temperature: Refer to schedule.
- D. Maximum working pressure: 125 psi.
- E. Design pre-charge pressure: Same as make-up water PR fill valve. Refer to schedule.
- F. Bladder Material: EPDM, compatible with propylene glycol.

2.5 AIR PURGERS

- A. Manufacturers:
 - 1. Amtrol
 - 2. Armstrong
 - 3. ITT Bell & Gossett
 - 4. Spirotherm
 - 5. Taco
 - 6. Thrush
- B. Model: ITT Bell & Gossett 107A
- C. Float actuated, non-modulating, rated at 175 psig at 150 °F and 150 psig at 250°F.

2.6 AIR VENTS

- A. Manufacturers:
 - 1. Amtrol
 - 2. Armstrong
 - 3. ITT Bell & Gossett
 - 4. Spirotherm

- 5. Taco
- 6. Thrush

- B. Resilient Parts: EPDM
- C. Vents on Pipes Size 2" and Smaller: ITT Bell & Gossett Model 4V
- D. Vents on Pipes Size 2½" and Larger: ITT Bell & Gossett Model 107A
- E. Vents on Air Purgers: ITT Bell & Gossett Model 97
- F. Automatic Air Vents: ITT Bell & Gossett Model 97

2.7 PRESSURE REDUCING FILL VALVES

- A. Manufacturers:
 - 1. Apollo
 - 2. ITT Bell & Gossett
 - 3. Taco
 - 4. Thrush
 - 5. Watts
- B. Size: ¾"
- C. Model:
 - 1. 8 psig to 25 psig: ITT Bell & Gossett Model 7-12
 - 2. 25 psig to 60 psig: ITT Bell & Gossett Model 7

2.8 PRESSURE TEMPERATURE TAPS

- A. Manufacturers:
 - 1. Omega
 - 2. Petes Plug
 - 3. Sisco
 - 4. Trerice
 - 5. Watts
- B. Construction:
 - 1. Body and Cap: Brass
 - 2. Pressure: 500 psig
 - 3. Temperature: 350°F
 - 4. Core: EPDM, self-sealing.

5. Cap: Gasketed, threaded.
6. Size: 1/4" NPT or 1/2" NPT.

C. Thermometer:

1. Number required: 1
2. Dial diameter: 2"
3. Range: 0° to 220°

D. Pressure Gauge Adapter:

1. Number required: 1
2. Model: GA-125

E. Pressure Gauge:

1. Number required: 1
2. Dial diameter: 4½"
3. Range: 0 to 100 psig
4. Accuracy: ½%

2.9 BALANCING VALVES

- A. See Section 23 05 23.

2.10 THERMOMETERS

A. Manufacturers:

1. Dwyer
2. Ernst
3. Marsh
4. Trerice
5. Winters

B. Housing: 9" adjustable angle stem.

C. Tube: Lens front, red or blue liquid.

D. Range:

1. Chilled water, condenser water, 0°F to 100°F.
2. Hot water, 30°F to 240°F.

2.11 PRESSURE GAUGES

A. Manufacturers:

1. Dwyer
2. Ernst
3. Marsh
4. Trerice
5. Winters

B. Construction:

1. Liquid filled.
2. Minimum 3 1/2" diameter face with 270 degree arc.
3. Range: As required to keep normal operating point in mid 2/3 to 3/4 of dial.
 - a. Use 30" vacuum to 100 psi gauge for pumps designed to operate at pressures up to 75 psig total pressure. (Total pressure = required pump-off static pressure plus scheduled pump head).
4. Use higher pressure ranges as required such that scheduled total pressure does not exceed an operating point above ¾ range of dial.

C. Accuracy: 1% of full scale over middle of range.

2.12 POT FEEDERS

A. Manufacturers:

1. Griswold
2. J.L. Wingert
3. Neptune
4. Wessels

B. Construction: Minimum 200 psi at 200 degrees F.

C. Size: 2 gal.

2.13 AIR SEPARATORS

A. Manufacturers:

1. Amtrol
2. Armstrong
3. ITT Bell & Gossett
4. John Wood

5. Spirotherm
6. Taco
7. Wessels

- B. Constructed and nameplated for 125 psig working pressure and stamped in compliance with ASME boiler and pressure vessel code.
- C. Provide blow-down connection.
- D. Provide integral strainer.

2.14 RELIEF VALVES

- A. Manufacturers:
 1. Apollo
 2. ITT Bell & Gossett
 3. Kunkle
 4. Spence
 5. Taco
 6. Thrush
 7. Watts
- B. Type: ASME
- C. Size: Maximum input capacity of system at design pressure.
- D. Setting: Operating pressure of system plus 2 psi unless otherwise noted.

2.15 PROPYLENE GLYCOL

- A. Manufacturers:
 1. Dow Chemical Company
 2. Dupont
 3. Dynalene
 4. Interstate Chemical Company, Inc.
- B. Model: Dow Chemical Company Dowfrost
- C. Type: Propylene Glycol with corrosion inhibitors. For glycol concentrations less than 30%, provide additional inhibitors per manufacturer's recommendations for adequate corrosion and microbial growth protection. Added inhibitors must be compatible with the glycol and its inherent inhibitors.

2.16 REDUCED PRESSURE BACKFLOW PREVENTER

- A. See Section 22 10 00.

2.17 VENTURI FLOW MEASUREMENT DEVICES

- A. Manufacturers:

1. Gerand
2. Hyspan
3. Presso
4. Veris

- B. Identification:

1. Provide engraved metal tag indicating Beta Ratio or flow curve.
2. Hang on chain to clear insulation.

- C. Size:

1. Select Beta ratio to provide 10" to 30" water gauge meter reading.

2.18 COIL CONNECTION KITS

- A. Manufacturers:

1. Hays.
2. IMI Flow Design.
3. Victaulic 78Y/78U.

- B. Combination Y-Strainer, union, PT port, and ball valve

1. 400 psi maximum CWP, available as sweat x sweat; sweat x female threaded; female threaded x sweat; female threaded x female threaded; DZR brass body consisting of a full port ball valve and strainer with flow measuring ports.
2. Ball valve shall be complete with double O-ring seal, plated ball, blow-out proof stem, and steel handle with vinyl grip. Strainer shall be Y-pattern, with 20 mesh stainless-steel screen and blow-down port. Strainer/ball combination shall provide a simplified hookup to protect the coil and modulating valve. To be suitable for operating temperatures up to 230°F.

- C. Coil Hoses

1. 375 psi maximum CWP (varies by size), stainless-steel braided hose and a synthetic polymer core with stainless ferrules; available as male by female swivel and male by

male swivel and in three lengths: 12", 24" or 36". Suitable for operating temperatures up to 230 degrees F.

2. Install hoses free of kinks and coordinated with other equipment/accessories.
3. Hoses shall be insulated to meet requirements of 23 07 00 (Mechanical Insulation).
4. Provide air vents at all high points in piping systems. If the rigid pipe connection to the hose is higher than the coil air vent, provide additional air vent at high point.

D. Combination Union Port fitting with PT Port and Manual Air Vent

1. 400 psi maximum CWP, available as sweat x male threaded; female threaded x male threaded; DZR brass body with manual air vent port and pressure/temperature port, with EPDM seals. Union port fitting shall provide a simplified terminal hookup for installation at coil outlets. Suitable for operating temperatures to 230°F.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

- A. Install horizontal piping level (except drain piping and as otherwise noted) and parallel to building construction. All vertical piping to be plumb.
- B. Make any changes in direction with fittings, do not kink or bend piping. Elbows are to be long radius type wherever possible.
- C. Where pipes pass expansion joints or structural elements subject to movement, provide flexible expansion compensators and supports or piping expansion loops to allow for movement without adverse effects.
- D. Regardless of how shown on schematic piping diagrams, do not install a tee so that flow enters from opposite directions.
- E. Do not rearrange piping in a manner to increase pressure drop without written approval from Architect/Engineer.
- F. Install drains at all low points of the system.

3.2 EQUIPMENT CONNECTIONS

- A. Do not allow weight of piping or expansion of piping to put stress on equipment connections.
- B. Pipe equipment to allow for servicing (coil pull, tube pull, etc.) with minimum of disruption to piping.
- C. Provide unions or flanges at all equipment connections.

3.3 FREEZE PROTECTION

- A. Fill systems with indicated solution by volume of propylene glycol and water.
- B. Pre-mix all solutions before injection into system.

3.4 AIR VENTS

- A. Install automatic air vents at high points in equipment rooms.
- B. Install manual air vents at high points not in equipment rooms.

3.5 RELIEF VALVES

- A. Install pressure relief valves on all vessels, which may be isolated from other relief valves by closing valves. Pipe discharge full size to nearest floor drain.

3.6 PRESSURE TEMPERATURE TAPS

- A. In Pipes 2" and Smaller: Install taps in tee at change in direction so inserted thermometer stem will be parallel to center line of pipe.
 - 1. Add extra change in direction if necessary.
 - 2. Allow clearance for insertion of thermometer.
 - 3. Ensure that gauge or thermometer will be in a readable position.

3.7 HOT TAPS

- A. Hot taps are to be used only after written permission by the Architect/Engineer. Submit intended procedure with request.

3.8 CLEANING

- A. Flush the system thoroughly with clear water.
 - 1. Drain system.
 - 2. Clean all strainers.
- B. Refill system with solution of 1 lb. trisodium phosphate to 50 gal of system water.
 - 1. Heat system to design temperature.
 - 2. Circulate as required to fully clean the piping system. Continuously check strainers and verify they have been clean for a minimum of two hours.

- 3. Stop circulation and drain system.
- 4. Clean all strainers.
- C. Fill system with fresh water or water/glycol mixture.

3.9 CORROSION PROTECTION

- A. Provide dielectric unions at unions between piping of different materials.
- B. See Section 23 25 13 for water treatment program to be provided.
- C. All components of system shall be compatible with propylene glycol and water solution.

3.10 PREINSULATED/BURIED PIPE

- A. Provide closed cell insulation, seal joints with waterproof mastic. Minimize joints below grade.
- B. Provide thrust blocks at all changes in direction for pipe 8" and larger.
- C. Comply with Division 2 and Section 23 05 03 for excavation and backfill requirements.
- D. The installing contractor shall handle the system in accordance with the directions furnished by the manufacturer and as approved by the engineer.
- E. A minimum of six inches (6") of sand or fine gravel bedding shall be placed all around the pipe in the trench. This bedding/fill shall be hand tampered and compacted around the pipes in six-inch (6") lifts until the fill is six inches (6") above the top of the jacketing material. The remaining height of the trench shall be evenly and continuously backfilled and compacted in uniform six-inch (6") lifts with suitable clean excavated soil.

3.11 PRESSURE GAUGES

- A. Pump assemblies: Use a single gauge with multiple taps to pumped system (strainer inlet, strainer outlet, pump suction and pump discharge) per the detail on the drawings.
- B. Allow clearance for removal of gauge.
- C. Ensure that gauge will be in a readable position.

END OF SECTION 23 21 13

SECTION 23 21 23 - HVAC PUMPS

PART 1 - GENERAL

1.1 MOTOR HORSEPOWER

- A. Do not increase or decrease motor horsepower from that specified without written approval from Architect/Engineer. See Section 23 05 01.
- B. Select pumps so that for single pump application at a minimum, brake horsepower does not exceed motor horsepower at rating point, and does not exceed motor horsepower plus service factor on impeller curve at 125% rated flow. For parallel pump application motor horsepower shall be selected such that pump can operate at any point on the pump curve without overloading.

1.2 PARALLEL PUMP SELECTION

- A. Select pumps for parallel pump application such that a single pump can operate and not exceed the end operating point of the pump curve.

1.3 SUBMITTALS

- A. Manufacturers Product Data: Submit manufacturer's product data on pumps.
 - 1. Include pump curve and mark rating point. Also include single pump operating point for a parallel pump application.
 - 2. Show maximum allowable operating temperature and pressure.
 - 3. Note in red any deviations from specified construction.
 - 4. Show impeller diameter indicate maximum impeller diameter for pump volute provided, and indicate if impeller is machined down.

PART 2 - PRODUCTS

2.1 LARGE INLINE PUMPS (VERTICAL MOTOR)

- A. Manufacturers:
 - 1. Armstrong
 - 2. Aurora
 - 3. Bell & Gossett
 - 4. Mepco

5. Peerless
6. Paco
7. Taco

B. Construction:

1. Pump Body: Cast Iron, Double or Single suction as shown on drawings. Provide mounting pedestal or bolt circle for flange where floor support is required.
2. Impeller: Bronze, enclosed.
3. Shaft: Steel with bronze sleeve or stainless steel.
4. Shaft Seal: Mechanical, internally flushed, carbon-ceramic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install pumps to allow complete removal without dismantling connecting piping.
2. Provide air cock and drain connection on pump casing.
3. Decrease from line size with long radius reducing elbows or concentric reducers, or suction diffusers.
4. Support piping adjacent to pump so that no weight is carried on pump casings.
5. Comply with manufacturers recommendations for support of inline pumps. Provide support for motors when mounted horizontally. Verify Manufacturer's allowable motor position and install accordingly.
6. Provide supports under elbows on pump suction and discharge line.
7. Provide one pressure gauge with piping and gauge cock to measure pressure of strainer inlet, pump suction, and pump discharge.
8. Manufacturer's representative shall verify proper pump operation.

B. Motor Mount – Inline Pumps:

1. Verify motor position (vertical or horizontal) with manufacturer's installation instructions.
2. Provide proper pump support in accordance with manufacturer's installation instructions. Do not support pump from equipment.
3. Provide adequate clearance around pump for motor and shaft removal.

C. Lubrication: After completion of the system and before start-up, lubricate the pumps.

D. For inline pumps with motors 7.5 HP and larger, provide a suitable lifting point (eye bolt, strut channel) directly over the motor to aid in removal of the rotating element.

E. Pipe drip pan base to floor drain.

- F. Fully grout base-mounted pumps to housekeeping pads or inertia base per manufacturer's recommendations.

END OF SECTION 23 21 23

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

- A. Installer: A firm with at least five years of successful installation experience on projects with refrigerant piping similar to that required for this project.

1.2 REGULATORY/REQUIREMENTS

- A. Comply with applicable requirements of the Clean Air Act, State of Colorado and Routt County Regulations concerning handling of refrigerants.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING

- A. Type ACR copper tube with wrought copper fittings.
- B. End Caps:
 - 1. Provide factory applied plastic end caps on each length of pipe and tube.
 - 2. Maintain end caps through shipping, storage and handling as required to prevent pipe end damage and eliminate dirt and moisture from inside of pipe and tube.

2.2 SHUT-OFF VALVES

- A. Manufacturers:
 - 1. Design Basis: Henry
 - 2. Other Acceptable Manufacturers:
 - a. Imperial
 - b. Mueller
 - c. Superior
- B. Size 7/8 Inch and Smaller:
 - 1. Model: Series 600.
 - 2. Type: Pack-less diaphragm.

3. Material: Forged bronze.
4. Flow: Non-directional.
5. Servicing: Diaphragm changeable under line pressure.

C. Size 1-1/8 Inch and Larger:

1. Model: Series 200.
2. Type: Wing cap, back seating.
3. Material: Bronze.

2.3 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:

1. Design Basis: Mason
2. Other Acceptable Manufacturers:
 - a. Flexonics
 - b. Metraflex

B. Braided bronze with copper tube ends, compatible with refrigerant type for system

C. Flexible connector shall be line size or connection size, whichever is larger.

2.4 REFRIGERATION SPECIALTIES

A. Filter Drier:

1. Conform to ARI Standard 710.
2. Sizes 1/2" and larger - interchangeable core, full flow.
3. Sizes smaller than 1/2" - sealed type.
4. Minimum burst pressure - 1500 psig.

B. Sight Glass:

1. Double port moisture indicating, reversible color indicator.
2. Removable sight glass and moisture indicating element.
3. Furnish with a protective cover.

C. Expansion Valve:

1. Thermostatic type, diaphragm or bellows operated.
2. External superheat adjustment factory set for 10°F superheat (adjustable).
3. Compatible with refrigerant type for the project.
4. Pressure rated per project requirements.

5. Power elements and valve size shall be as recommended by the manufacturer, for the service intended.

D. Solenoid Valve:

1. Provide solenoid valve for systems 25 tons and larger.
2. Compatible with refrigerant type for the project.
3. Valve shall fail in closed position (power open).

E. Acceptable Manufacturers:

1. Alco
2. Sporlen

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Run piping level or plumb, except slope gas piping to compressor with a minimum number of elbows.
- B. Provide oil traps at bottom of suction risers. Size risers for proper oil return.
- C. Size lines for total pressure drop not to exceed 2°F saturation temperature.
- D. Provide necessary flexibility for vibration and expansion with offsets and loops, not expansion joints.
- E. Provide flexible connectors at all unit connections.
- F. Replace air in pipe with dry nitrogen to prevent corrosion during soldering.
- G. Install valves, sight glasses, filter-driers, and accessories, furnished by equipment supplier, but not factory installed.
- H. Insulate all underground refrigerant lines with ½" flexible foam.
 1. Use un-slit covering.
 2. Carefully cement all joints.

3.2 HANGERS

- A. For insulated piping, provide hangers of size to fit outside insulation.
- B. For non-insulated piping, provide hangers with elastomer insert to prevent damage to piping from vibration.

3.3 TESTING AND DEHYDRATION

- A. Use the following procedure to test and hydrate the systems:
 - 1. Isolate any elements which would be damaged by test pressures.
 - 2. Test system with trace gas using an appropriate leak detector.
 - 3. Repair or replace leaking elements of system and re-test.
 - 4. After system has been proven to be free of leaks, evacuate it with a high efficiency vacuum pump to 2.5 mm of mercury absolute.
 - 5. Allow the system to stand under vacuum for 24 hours.
 - a. Then, if a vacuum of 2.5 mm can be drawn within 30 minutes, the system shall be considered dry.
 - b. If not, the procedure shall be repeated.
 - 6. Break the final vacuum by charging with the correct refrigerant.

END OF SECTION 23 23 00

SECTION 23 25 13 - HVAC SYSTEM CHEMICAL TREATMENT

PART 1 - GENERAL

1.1 SCOPE

- A. Furnish and install chemical treatment systems for closed hydronic systems where shown on the Drawings and as specified in this section.
- B. Work under this section shall include providing equipment, chemicals, and service related to alter treatment for the chilled and heating water systems.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 21 Pipe and Pipe Fittings.
- B. Section 23 21 13 Hydronic Piping.

1.3 QUALITY ASSURANCE

- A. The chemical treatment program shall be administered by a firm regularly engaged in the field of water treatment with a minimum of five years of experience in the immediate area of the job site location, and similar sized projects.
- B. The water treatment contractor shall have laboratory facilities, both central and field, to service the Owner's account.
- C. The water treatment contractor shall have local warehousing and will not be allowed to overstock chemical on premises.
- D. A single water treatment company shall be responsible for all products and services.
- E. Comply with the requirements of the following agencies:
 - 1. The applicable water quality control district.
 - 2. The local sanitation district or sewage agency.
 - 3. Applicable industrial waste regulations.
 - 4. The California State Water Resources Board.
 - 5. Conform to OSHA Standards for the handling and storage of hazardous chemicals.

1.4 SUBMITTALS

- A. Provide product data for each piece of equipment installed the system and for each chemical used.
- B. Provide shop drawings for control panel, including internal and external wiring diagrams, dimensions, etc.
- C. Provide operation and maintenance manuals for all equipment.
- D. Material Data Safety Sheets shall accompany all chemicals delivered to the job site.

PART 2 - PRODUCTS

2.1 PRE-STARTUP CLEANER

- A. Furnish pre-startup liquid detergent dispersant cleaner for flushing and cleaning of water systems to remove oil and foreign matter from piping and equipment prior to final filling of systems. Chemical shall not be injurious to persons, piping, pipe joint compounds, packings, coils, valves, pumps, and their mechanical seals, tubes, or other parts of the system.
- B. Furnish complete instructions dictating quantities of cleaner to use, method of cleaning, duration or operation.

2.2 CHEMICALS

- A. A buffered Molybdate and/or Nitrite based corrosion inhibitor shall be provided to initially treat the closed systems and added as required for 1 year from date of owner acceptance. This treatment must contain a copper inhibitor and a borate buffer.
- B. Any treatment must be compatible with glycol installed in glycol/water systems.

2.3 POT FEEDER

- A. Provide a five (5) gallon pot feeder piped around the main closed loop system circulating pumps as indicated on the drawings. The feeder shall consist of a steel tank with operating pressure of 200 psi. A 3½" quick open cap with "O" ring seal shall be provided to add water treatment chemicals.

2.4 COUPON HOLDER

- A. Provide coupon rack with coupon holders, flow control and isolation valves. Coupon racks shall be installed in all closed and open hydronic piping systems.

- B. Coupon Holders shall be similar to Pulsafeeder, Inc. Model CCR-4.
- C. The Water treatment contractor shall install the coupons in the coupon holders and submit a written report to the Owner at the end of each 90 days, during the one year warranty period as to the condition of each system being treated.

2.5 CLOSED SYSTEMS – GLYCOL FEEDER

- A. Glycol Feeder Assembly
 - 1. Manufacturers:
 - a. Advantage Controls
 - b. J.L. Wingert
 - c. Neptune
 - d. Approved equal
 - 2. Provide and install equipment for the automatic feed of a glycol solution. System components shall be as specified.
 - 3. Glycol feeder shall be a packaged system consisting of a storage tank assembly, positive displacement pump, control panel, pressure relief valve, adjustable pressure switch, and low-level switch.
 - 4. Feeder storage tank assembly shall consist of one (1) 50 gallon polyethylene tank with cover equipped with two (2) 3/4" bulkhead fittings located 3" from the bottom of the tank for pump suction and drain. The storage tank shall be mounted on a steel tank stand equipped with a side-mounting platform for the glycol pump.
 - 5. Glycol control panel with red low-level warning light, alarm bell, alarm silence switch and hand/off/auto switch, prewired with terminal strip connections in NEMA 4X enclosure.
 - 6. Pressure relief valve which shall be set at 75 psi, with relief setting adjustable up to 100psi with an Allen wrench.
 - 7. Pressure switch for glycol pump control shall be adjustable to provide glycol pump start/stop. Ranges: 5 to 65 psi.
 - 8. Low level drum caddy shall shut off glycol pump in the event of low glycol level in storage tank. Caddy shall be wired for pump disconnect and warning device activate circuits.
- B. Glycol: An inhibited industrial grade propylene glycol shall be furnished for proper percentage of glycol solution within the system. Refer to Section 23 21 13 for glycol requirements.
- C. Test Equipment: Furnish a hydrometer type test kit for the determination of percent/freeze point of propylene glycol solutions.

PART 3 - EXECUTION

- 3.1** Provide a one year supply, from date of startup, of the recommended formulas for the prevention of scale, corrosion, and biological growth in the recirculating system.
- 3.2** All formulations must be compatible with system construction materials and meet or exceed all environmental requirements.
- 3.3** The water treatment company will supply all testing equipment and reagents, necessary to properly maintain the treatment program.
- 3.4** The water treatment company will provide a water treatment service program for a period of one year from system startup. This program shall include: startup assistance, plant personnel training, monthly service calls and inspection of system equipment. Provide owner with copy of field service report including performance test required levels vs. Field measurements.
- 3.5** Provide quarterly laboratory analysis and report of coupons.

END OF SECTION 23 25 13

SECTION 23 26 00 - ENERGY AND WATER METERING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. In addition to the work covered under this section, comply with description of individual systems under other sections of the Specifications.

PART 2 - PRODUCTS

2.1 BTU METERING STATIONS

- A. Manufacturers:
1. Basis of Design: Onicon System 10
 2. Other Manufacturers:
 - a. Badger
 - b. Cadillac Meter
 - c. Omega
 - d. Approved equal meeting the specification below.
- B. Components: BTU metering station shall consist of a flow meter, two temperature sensors, a BTU meter, temperature thermowells, and all required mechanical installation hardware. Provide certificate of NIST traceable calibration with each metering station.
- C. Serial Communication: BTU metering station shall be capable of communicating with the Building Management System via serial communication interface and/or individual analog or pulse outputs. BTU metering station shall be capable of providing the following points:
1. Total energy consumption
 2. Total energy demand
 3. Flow rate
 4. Supply temperature
 5. Return temperature
- D. Programming: BTU meters shall be factory programmed for specific application and shall be re-programmable in the field.
- E. Temperature Sensors: Temperature sensors shall be loop-powered, current based (mA) sensors and shall be bath-calibrated and matched for the specific temperature range for each

application. The calculated differential temperature used in the energy calculation shall be accurate to within $\pm 0.15^{\circ}\text{F}$.

- F. Flow Meter: Provide Onicon F-3200 series inline electromagnetic flow meter complete with integral or remote electronics module. Electronics module shall include backlit graphic display and keypad. Connections to piping system shall be ANSI class 150 flanged. Flow tube shall be epoxy coated steel. Sensing electrodes shall be 316 stainless steel. Liner shall be polypropylene or ebonite for low temperature service or PTFE for hot water service. Each flow meter shall be individually wet-calibrated and accurate to within $\pm 0.2\%$ of reading from 1.6 to 33 feet per second velocity. Provide certificate of calibration with each flow meter. Output signal shall be 4-20 mA and programmable pulse. Flow meter shall be capable of measuring bi-directional flow. For installations in non-metallic pipe, install grounding rings between flanges. Each flow meter shall be factory programmed for the specific application and shall be re-programmable in the field. Install meter per manufacturer's recommendations including minimum upstream and downstream straight pipe runs.

2.2 NATURAL GAS THERMAL MASS METERS

A. Manufacturers:

1. Basis of Design: Onicon Series 5500

- a. Line sizes 1-1/2" and smaller: Provide inline type flow meter with integral flow conditioner.
- b. Line sizes 2" and larger: Provide insertion type flow meter with flow conditioner. Flow meter shall be hand-insertable up to 100 psi. Provide all installation hardware necessary to enable insertion and removal of meter without system shutdown.

2. Other Manufacturers:

- a. Cadillac Meter (vortex type)
- b. Sage
- c. Sierra
- d. Approved equal meeting the specification below.

- B. Components: All wetted metal components shall be 316 stainless steel. Flow meter shall provide standard feet per minute (SFPM) flow readings from a pair of encapsulated platinum sensors and shall not require additional temperature or pressure compensation.
- C. Calibration: Each flow meter shall be individually wet-calibrated against a standard directly traceable to NIST. Provide certificate of calibration with each flow meter.
- D. Accuracy: Accuracy shall be within $\pm 1\%$ of rate from 500-7000 SFPM and $\pm 2\%$ of rate from 100-500 SFPM. Overall turndown shall exceed 1000:1.

- E. Display: Flow meter shall be equipped with an integrally-mounted graphical display. Flow meter shall continuously display information that may be used to validate the calibration of the meter.
- F. Communication: Output signals shall consist of the following: (1) analog 4-20mA output and (1) scalable pulse output for totalization.

2.3 DOMESTIC HOT AND COLD WATER METERS

- A. Manufacturers:
 - 1. Basis of Design: Onicon Series F-3200 Inline Electromagnetic Flow Meter
 - 2. Other Manufacturers:
 - a. Badger
 - b. Cadillac Meter
 - c. Omega
 - d. Approved equal meeting the specification below.
- B. General: Provide inline-type electromagnetic flow meter complete with integral or remote electronics module. Flow meter shall be capable of measuring bi-directional flow. For installations in non-metallic pipe, install grounding rings between flanges. Install meter per manufacturer's recommendations including minimum upstream and downstream straight pipe runs.
- C. Construction: Connections to piping system shall be ANSI class 150 flanged. Flow tube shall be epoxy coated steel. Sensing electrodes shall be 316 stainless steel. Liner shall be polypropylene or ebonite for low temperature service or PTFE for hot water service.
- D. Calibration: Each flow meter shall be individually wet-calibrated and accurate to within +/- 0.2% of reading from 1.6 to 33 feet per second velocity. Provide certificate of calibration with each flow meter.
- E. Programming: Each flow meter shall be factory programmed for the specific application and shall be re-programmable in the field.
- F. Display: Electronics module shall include backlit graphic display and keypad.
- G. Communication: Output signal shall be 4-20 mA and programmable pulse.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturers recommendations including minimum inlet and outlet straight pipe diameters.
- B. Meter electronics and meter components with plastic housings shall not be installed in return air plenums. Where meters are specified to be installed in a location within a return air plenum, provide remote-mounted electronics or relocate meters to a location outside of a return air plenum.

END OF SECTION 23 26 00

SECTION 23 31 13 - DUCTWORK

PART 1 - GENERAL

1.1 INDUSTRY STANDARDS

- A. Construct ductwork to meet all functional criteria defined in Section 11 of the 2005. SMACNA “HVAC Duct Construction Standards, Metal and Flexible”, Third Edition. Comply with SMACNA recommendations for fabrication, construction and details, and installation procedures, except as otherwise indicated.
- B. Comply with American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), except as otherwise indicated.
- C. Comply with SMACNA “HVAC Air Duct Leakage Test Manual” for testing of duct systems.

1.2 SUBMITTALS

- A. Detailed ductwork shop drawings, which include sizes, layouts, and pressure classifications, must be properly submitted. Any ductwork installed without prior written approval by the engineer of record shall be replaced at the expense of the contractor.
- B. Shop Drawings: Submit shop drawings for:
 - 1. Transition elbows.
 - 2. Seal and reinforcing schedule for all ductwork fabrication types.
 - 3. Turning vane and turning vane installation.
- C. Product Data: Submit manufacturer’s product data on the following:
 - 1. Duct lining.
 - 2. Duct lining adhesive.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS

- A. All interior ducts shall be constructed with G-90 or better galvanized steel (ASTM A653/653M) LFQ, chem treat. Exterior ductwork or duct exposed to high humidity conditions (i.e., kitchen exhausts) shall also be G-90 or better galvanized steel LFP, chem treat.

- B. Stainless-steel duct shall be fabricated from lock forming grade, 300 series, ASTM-AI67, No. 4 general purpose finish. Protect finish with mill applied adhesive protective plastic/paper throughout construction.
- C. Aluminum duct shall be fabricated from lock forming grade, alloy 3003-HI4, ASTM B209. Reinforcing angles, bars, tie rods, and other structural members shall be alloy 6061-T6. Hangers shall be 6061-T6 aluminum, or galvanized or painted steel with a dielectric isolation pad between the dissimilar metals.
- D. PVC coated ductwork shall be fabricated from galvanized steel; cleaned and primed with a baked-on PVC coating. PVC coating shall be minimum 0.035 lbs./Sq. Ft. at 5 Mills, 90 units a scale shore durometer, flame spread rating 25, smoke developed 50, UL 181, Class I duct. Provide compatible touch up paint to repair damage.
- E. Ungalvanized carbon steel shall be lockforming grade, hot rolled steel conforming to ASTM A366 or A619.
- F. Ductwork designated for painting (by Others) shall be provided with "Paint Lock" finish to accept primer and paint. See Architectural and mechanical documents for designated locations.

2.2 RECTANGULAR DUCT

- A. Construct rectangular ductwork to meet all functional criteria defined in Section 11, of the SMACNA "HVAC Duct Construction Standards Metal and Flexible" 2005 Edition. All ductwork must comply with all local, state and federal code requirements.
- B. Where the standard allows the choice of external reinforcing or internal tie rods, only the external reinforcing options shall be used.
- C. Pittsburgh lock shall be used on all longitudinal seams. All longitudinal seams will be sealed with mastic sealant. Snaplock is not acceptable.
- D. Ductmate or W.D.C.I. proprietary duct connection systems will be accepted. Duct constructed using these systems will refer to the manufacturers guidelines for sheet gauge, intermediate reinforcement size and spacing, and joint reinforcements.
- E. Formed on flanges (T.D.C./T.D.F./T-25A/T-25B) shall be constructed as SMACNA T-25 flanges, whose limits are defined on Page 2.76 2005 SMACNA Manual, Third Edition. No other construction pertaining to formed on flanges will be accepted. Formed on flanges shall include the use of corners, bolts and cleat.
- F. Ductmate type systems that use a butyl Rubber Gasket which meets Mil-C 18969B, Type II Class B, TT-C-1796 A, Type II Class B, and TTS-S-001657 must also pass UL-723. This material, in addition to the above, shall not contain vegetable oils, fish oils, or any other type vehicle that will support fungal and/or bacterial growth (as defined in 21CFR 177, 1210 closures with sealing gaskets for food containers).

- G. Aluminum duct shall be fabricated using the aluminum thickness equivalence table in the standard. Simply increasing the thickness by two gauges is not acceptable.
- H. Fittings shall be constructed and reinforced as ductwork according to the longest span.

2.3 ROUND AND OVAL DUCT

- A. Round and oval duct shall be galvanized steel, constructed in accordance with Section 11 of the 2005 SMACNA "Duct Construction Standards, Metal and Flexible", except as noted.
 - 1. Lighter gauge factory made duct with an Intermediate standing rod may be used. Submit product data sustaining the equivalency of such duct into SMACNA standard duct.
- B. Minimum duct gauge shall be 26 gauge.
- C. Round ductwork shall be spiral lock seam construction only. Longitudinal seam duct is not acceptable. Gauges shall be in accordance with SMACNA Duct Construction Standard and fittings in accordance with SMACNA Duct Construction Standard, except as noted:
 - 1. Joints 0"-20" diameter, interior slip coupling beaded at center, fastened to duct with sealing compound applied continuously around joint before assembling and after fastening. Wrap joints with 3-inch wide duct tape.
 - 2. Joints 21"-72" diameter, use 3-piece, gasketed, flanged joints consisting of 2 internal flanges (with integral mastic sealant) split to accommodate minor differences in duct diameter, and one external closure band designed to compress gasketing between internal flanges. Example: Ductmate Spiralmate or equal.
 - 3. Joints 73" diameter and up, use companion angle flanged joints only as defined on page 3-6 of the SMACNA Manual. Refer to manual for proper sizing and construction details. Ductwall to be welded longitudinal seams.
- D. Fittings shall be continuously welded, standing seam, or spot welded and sealed. Metal thickness and reinforcing shall be equivalent to the requirements of the largest span.
 - 1. All elbows greater than 45" shall be radius type, $R=1.5$ times duct diameter.
 - 2. Elbows less than 6" shall be of die stamped construction. Elbows 6" or greater shall be 5-gore construction.
 - 3. Diverging and converging flow fittings shall be constructed with no excess material projecting from the body into the branch tap entrance. All such fittings shall be 45° "shoe" entrance, wye plus elbow, or 45° lateral branch. Special fittings such as heel tapped elbows and bullhead tees may be used only where shown on drawings. Adjustable elbows and straight saddle taps shall not be used. Low pressure adjustable elbows acceptable.

- E. Where round ductwork 24" and smaller is indicated to be in areas exposed to view, utilize one of the following transverse joining methods:
 - 1. Beaded sleeve connections with duct sealant applied to the sleeve joint prior to attachment.
 - 2. Beaded sleeve connections with gasket integral to sleeve.
 - 3. No sealant shall be visible on the outside of the duct.
- F. Where round ductwork over 24" is indicated to be in areas exposed to view, utilize Van Stone flange joints with non-extruding gasket. No sealant shall be visible on the outside of the duct.

2.4 DISHWASHER EXHAUST DUCT

- A. Material: Stainless steel.
- B. Seams: Welded.
- C. Drainage: Run duct vertical or pitch toward hood or dishwasher connection.
- D. Fabricated Dishwasher hood:
 - 1. Stainless steel with welded seams.
 - 2. Provide 1" gutter on all sides with ¾" coupling. Route to nearest approved receptor.

2.5 GREASE LADEN DUCT

- A. Material: 16-gauge carbon steel; or 18-gauge stainless steel.
- B. Seams: Welded or brazed.
- C. Materials in accordance with NFPA 96.
- D. Refer to 23 33 00 for grease duct dampers.

2.6 GREASE LADEN DUCT (LISTED ZERO CLEARANCE GREASE DUCT)

- A. Manufacturers:
 - 1. Ampco
 - 2. Metal Fab
 - 3. Schebler
 - 4. Selkirk
- B. Description: The factory-built modular chimney shall be laboratory tested and listed in accordance with Underwriters Laboratories Standard UL 2221 classified for zero clearance to

combustibles. Sections shall bear the UL listing mark (or cUL listing mark for Canada).
Sections shall be sealed with banded flanges and joint sealant.

- C. Design: Manufacturer to provide sizing calculations and complete system design conforming to NFPA 96 requirements including cleanout access doors. Spray application designs or designs using standard galvanized ductwork are not permitted.
- D. Construction:
 - 1. Provide minimum of 3" ceramic fiber insulation between the inner and outer shells.
 - 2. Insulation is to be securely attached to the inner shell with steel straps and insulating pins welded to the inner shell. Stainless-steel centering clips shall be welded to the outer shell to maintain spacing and ensure concentricity of the shells.
 - 3. Breeching and chimney sections, when installed according to manufacturer's instructions, shall comply with national safety standards and building codes.
 - 4. Stacks terminating above a roof must terminate as required by code or NFPA 211.
- E. Inner Shell:
 - 1. Inner shell material shall be type 304 stainless steel.
 - 2. All inner shell seams shall be fully penetration welded the entire length of the pipe section. Riveted, tack or spot-welded seams are not permitted.
- F. Outer Jacket:
 - 1. Outer shell material shall be aluminized steel. If exposed to weather type 304 or 316 stainless steel shall be provided.
 - 2. All outer shell seams shall be full penetration welded the entire length of the pipe section. Riveted, tack or spot-welded seams are not permitted.
- G. Accessories:
 - 1. Provided tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners. Accessories shall be fabricated from similar materials and designs as vent-pipe straight sections.
 - 2. All accessories shall be listed and UL approved for same assembly.
- H. Installation: Grease duct to be installed in accordance with manufacture's UL approved instructions and in accordance with state and local codes.
- I. Warranty: Provide manufacturer's lifetime warranty for the entire duration the product is incorporated and used in its original installation.

2.7 CONTRACTOR FABRICATED CASINGS AND PLENUMS

- A. Unless required otherwise by drawings, single wall casings and plenums may either be contractor or factory fabricated where shown on drawings. All double wall casings and plenums shall be factory fabricated.
- B. Casings and plenums shall be constructed in accordance with the 2005 SMACNA "HVAC Duct Construction Standards," Third Edition and as specified below.
- C. All casings and plenums on the suction side of any fan, including return air outside air, or mixing plenum shall be constructed to 2" negative pressure class.
- D. Louver blank-off panels shall be constructed to 2" negative pressure class.
- E. All casings and plenums for relief and exhaust air shall be 2" positive or negative pressure class.
- F. All casings and plenums on the discharge side of supply fans shall be 4" positive pressure class.
- G. Single wall plenums shall be of the standing seam type construction. Submit shop drawings indicating overall dimensions, support details, corner and edge details, penetration details, equipment installation details, and pressure class.
- H. Seal all seams, edges, and corners with approved duct sealant.
- I. Casing materials shall be the same as that for the connected duct systems.
- J. Where automatic dampers may, completely shut off air flow and subject plenum of casing to fan close off pressure, install pressure relief panels, rated to open at 125%.

2.8 MISCELLANEOUS DUCTWORK MATERIALS

- A. General: Provide miscellaneous materials and products of the types and sizes indicated, and where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
- B. Double wall turning vanes shall be Harper double wall turning vanes fabricated from the same material as the duct. Tab spacing shall be SMACNA standard. Rail systems with non-standard tab spacings shall not be accepted. All tabs shall be used, do not skip tabs. Mounting rails shall have friction insert table, which align the vanes automatically. Vanes shall be subjected to tensile loading and be capable of supporting 250 lbs., when fastened per the manufacturer's instructions. Approved Systems: Ductmate PRO-Rail.
- C. Single wall splitter and turning vanes shall be custom fabricated as specified below.

D. Ductwork Support Materials: Except as otherwise indicated, provide galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.

E. **Type FDL** – Fiberglass Duct Liner:

1. Manufacturers:

- a. Certaineed
- b. Johns Manville
- c. Knauf
- d. Owens Corning

2. Model: Johns Manville Linacoustic RC with Permacoat (EPA registered antimicrobial coating), in accordance with UL 181, ASTM C1071, G21 and G22 with no observed growth.

3. Compliances:

- a. FSHH-1-545, Type I
- b. NFPA 90-A

4. Roughness: 0.0008 feet

5. Noise Reduction Coefficient: 0.85 or higher for 1-1/2" liner

6. Round Duct Liner: Spiracoustic Plus "snap-in" type with Permacote.

F. Duct Liner Adhesive:

1. Manufacturers:

- a. Childers CP-127 Chil-Quik
- b. CL Ward Duct Liner Adhesive
- c. Design Polymerics DP 2500
- d. Ductmate Industries, Inc. Gecko Glue
- e. Hercules Industries MTA500

2. Description: Water based.

3. UL Listings: UL 723/ASTM E84.

G. Duct Sealant:

1. Manufacturers:

- a. Childers CP-146 Chil-Flex
- b. CL Ward S Seal
- c. Design Polymerics 1010
- d. Ductmate PROseal
- e. Hercules Industries MTS200

2. Description: Non-hardening, water based, liquid or mastic elastic sealant with UV inhibitors for outdoor use
3. UL Listings: UL 181B-M and UL 723/ASTM E84.
4. Sealants shall contain no VOCs.

H. Duct Tape Sealing System:

1. Manufacturers:
 - a. Design Polymeric
 - b. Hardcast.
 - c. Approved equal
2. Model:
 - a. Tape: Hardcast DT
 - b. Indoor Adhesive: Hardcast FTA-20
 - c. Outdoor Adhesive: Hardcast RTA-50

I. Acoustical Duct Lagging:

1. Manufacturers:
 - a. Acoustical Solutions
 - b. Kinetics Noise Control
 - c. Sound Seal
2. Model: Sound Seal B-10 LAG/QFA-3, foil face loaded vinyl or lead barrier sheet fully bonded to a minimum 1" thick fiberglass blanket, nominal density of 1.0psf, install so jacket edges overlap by minimum of 6", minimum STC-27 tested by independent laboratory in accordance with ASTM E90 and E413, minimum insertion loss (IL) value at 500Hz shall be 23 and meets IMC flame/smoke ratings in accordance with ASTM E84.

J. Fiberglass ductboard is not accepted without prior written approval from the specifier.

K. Access doors shall be hinged or Ductmate Sandwich Type Access Doors manufactured by Ductmate Industries, Inc. Doors shall be of adequate size to allow easy access to hardware, which needs to be maintained.

L. Flexible Duct Connector:

1. Flexible duct connector shall be used where ductwork connects to fans of apparatus, or apparatus casing to fans.
2. Connectors will meet NFPA 90A and 90B specifications and provide an airtight and waterproof seal.
3. Indoor installations shall be Neoprene or vinyl coated fabrics.

4. Outdoor installations shall use Hypalon coated fabric.
5. Connector shall be Ductmate PROFlex or approved equal.

M. Roof-Mounted Duct Supports

1. Description: The Contractor shall design and detail the self-weight support of the roof-top HVAC ducts and their lateral stability to resist WIND and SEISMIC loads. The duct support design shall take into consideration the roof framing load carrying capacity for ME systems supported above and below the roof and distribute the load effect so as not to overload the roof framing. The system shall consist of vertical hot dipped galvanized or stainless-steel frame members or supports with welded 4"x4" base plate for permanent connection to the primary roof framing (not roof decking). The connection points of supports to the roof framing shall be provided with a "pitch pan" and shall be fabricated from the same material as the vertical support members. The "pitch pan" shall interface with roofing membrane, be filled with roofing asphalt, be flashed on all sides, and be provided with a waterproof seal. Mechanical Contractor shall coordinate support system with Roofing Contractor and receive his approval. Provide shop drawings of system for review.

2.9 FABRICATION

- A. Construct rectangular ductwork to meet all functional criteria defined in Section VII, of the SMACNA "HVAC Duct Construction Standards Metal and Flexible" 2005 Edition. This shall be subsequently referred to as the SMACNA Manual. All ductwork must comply with all local, state and federal code requirements.
- B. All "medium pressure" (systems with external pressures greater than 2" w.c.) duct systems shall be constructed for 4" W.C. positive and 1" W.C. negative static pressure and 3500 FPM velocity.
- C. See air handler and fan schedules for external pressure requirements. All pressures above 2" E.S.P. shall be medium pressure.
- D. All low-pressure ductwork is to be constructed for 2" W.C. positive and 1" negative static pressure and 2000 FPM.
- E. All negative pressure ductwork shall be constructed for a minimum of 2" W.C. negative and 2" W.C. positive static pressure and 2000 FPM velocity.
- F. All grease-laden negative pressure ductwork shall be constructed for a minimum of 4" W.C. negative static pressure and 3000 FPM velocity.

- G. Make all changes in direction using 1.5 radius elbows where possible. Use splitter vanes or mitered rectangular elbows with turning vanes otherwise.
1. Use single thickness splitter vanes for all radius elbows less than $1.5 D = r$.
 - a. D = diameter of duct or width of duct (in plane of change-in-direction).
 - b. r = radius of duct at duct center-line.
 - c. Use "Curve Ratios" of 0.45 or greater (as defined by figure 3-7 of the 1989 ASHRAE Fundamentals Handbook).
 2. Use single thickness turning vanes with no trailing edges in accordance with SMACNA Standards.
 - a. All mitered, rectangular elbows in series.
 - b. All mitered, rectangular elbows less than 36" in width (in plane of change-of-direction).
 3. Use double width, airfoil type turning vanes with no trailing edges for all rectangular elbows greater than 36" in width (in plane of change-of-direction).
 - a. Isolated elbows have a minimum of 3D straight duct upstream and downstream of the change-in-direction.
- H. Fabricate transition elbows with turning vanes at correct angle so entering and leaving edges are parallel or tangent to air flow.
- I. All branch duct take-offs shall use 45° laterals or 45° "pants-leg" type fittings.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTWORK

- A. Assemble and install ductwork in accordance with recognized industry practices, which will achieve air-tight and noiseless systems, capable of performing each indicated service.
- B. Install each run with a minimum of joints.
- C. Where ducts pass expansion joints or structural elements subject to movement provide flexible connections and supports to allow for movement without adverse effects.
- D. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth.
- E. Support ducts rigidly with suitable ties, braces, hangers and anchors of the type, which will hold ducts true-to-shape to prevent buckling. This Division is responsible for all duct supports.

- F. Seal ducts in accordance with SMACNA requirements for pressure class indicated. Refer to duct leakage testing requirements for required seal class.
 - 1. Indoor Ducts: Use liquid or mastic sealant, or tape system.
 - 2. Outdoor Ducts: Use tape system.
 - 3. Approved manufactured joining systems with gaskets may be used in lieu of transverse sealing.
- G. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible.
- H. Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of the building.
 - 1. Limit clearance to 0.5" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.
 - 2. Where possible, locate insulated ductwork for 1.0" clearance outside of insulation.
- I. In finished spaces, conceal ductwork by locating in mechanical shafts, hollow wall construction or above suspended ceilings.
- J. Where possible, avoid locating ducts on or near floor.
 - 1. Where ducts must be located low, provide metal trestle to protect duct at places where duct will be climbed over.
- K. Coordinate the layout with suspended ceiling and lighting layouts and similar finished work.
- L. Install access doors where necessary for inspection and maintenance.
 - 1. Provide additional 12" x 12" access door at each low leakage damper.
 - 2. Arrange access doors so that:
 - a. They open against the system air pressure wherever feasible.
 - b. Their latches are operable from either side, except where the duct is too small to be entered.
- M. Where ducts pass through non-fire-rated interior partitions below ceiling and exterior walls:
 - 1. Conceal the space between the construction opening and the duct or duct-plus-insulation with sheet metal flanges of the same gauge as the duct.
 - 2. Overlap the opening on all sides by at least 1-1½".
- N. Provide volume dampers at branch take-offs (except upstream of VAV boxes which should not have dampers).

- O. Provide conical or tapered taps with balancing dampers on all round ductwork takeoffs (except upstream of VAV boxes, which should not have dampers).
- P. Where space permits, round or oval ductwork of equivalent diameter may be substituted for unlined rectangular ductwork.
- Q. Provide aluminum ductwork for the first 20 feet downstream of any aluminum grille. Slope duct towards grille at 1/8" /ft.
- R. Do not modify ductwork in a manner that will increase external static pressure in the system without written approval from Architect/Engineer.

3.2 DUCT LINER INSTALLATION

- A. Refer to Application Schedule, 23 07 00.
- B. Ducts Exposed to Weather:
 - 1. Dimensions indicate free area.
 - 2. Seal ducts to three-inch static pressure standards, minimum.
 - 3. Provide a protective aluminum jacket around all exposed surfaces.
- C. Ductwork shall be insulated per Section 23 07 00. See Section 23 07 00 for additional insulation requirements on unlined and/or uninsulated ductwork.
 - 1. Coordinate lined duct and insulated duct prior to bid.
- D. Seal all exposed ends of liner with duct liner adhesive back a minimum of 2" from ends. Seal all joints in liner a minimum of 1" overlap. Seal all fasteners.
- E. Completely remove any loose material from each section of lined ductwork as it is installed.
- F. Interrupt duct liner a minimum of 18" upstream and 30 inches downstream of all electric resistance heaters in duct system. If ductwork is used for cooling, wrap that portion of duct which is not lined and extend insulation a minimum of 12" beyond lining in each direction.

3.3 GREASE EXHAUST DUCTS

- A. Install in accordance with Local Building Code and NFPA 96. Connect to hoods in accordance with the manufacturer's listing.
- B. Horizontal duct less than 75 feet in one run shall be pitched at 1/4" per foot towards the hood or a drain point. Those portions over 75 feet shall be pitched at 1" per foot.

- C. Enclose entire run of grease duct from hood to exterior wall or roof curb.
 - 1. See Section 23 07 00 for blanket type fire rated enclosure.
 - 2. See Division 07000 for shaft wall enclosure systems.
 - a. Install duct so a minimum of 6" and a maximum of 12" is maintained between duct and enclosure.
- D. Use no turning vanes, tie rods, dampers or other internal structures which will collect grease. All changes in direction shall be made with radius fittings.
- E. Provide cleanouts per NFPA requirements and as follows:
 - 1. Cleanouts shall be installed in the side or top of the duct, whichever is more accessible.
 - 2. When installed on the side, the bottom of the opening shall be a minimum of 1-1½" above the bottom of the duct.
 - 3. Ducts serving hoods with integral fire dampers shall have a clean out opening within 18" of the collar.
 - 4. Horizontal ducts shall either have one opening large enough for personnel entrance or at 12' intervals and at every change of direction.
 - 5. Vertical ducts shall either have one opening at the top large enough for personnel entrance and descent or a minimum 12" x 12" openings at every floor.
 - 6. Openings shall have a flanged frame, extending 1" off the ductwall. Closure panels shall be attached to the flange by means of threaded studs welded to the flange, protruding through holes in the panel and fastened by means of wing nuts. Provide "Fiber Frax" or equivalent high temperature (1500°F) rope type gasket bonded to either the gasket or panel.
 - 7. Provide access doors in the enclosure at all cleanouts.
 - a. Use UL listed methods for blanket type fire rated enclosures. See Section 23 07 00.
 - b. Use UL listed fire rated access doors in shaft wall enclosures. See Section 23 05 02.
 - 8. Provide access doors at each change in direction.
- F. All grease ducts parts exposed to weather shall be protected by one coat of corrosion and heat resistant primer and one coat of heat resistant paint. Alternatively, outdoor ductwork can be provided as Type 304 stainless steel.

3.4 DRYER EXHAUST DUCT

- A. Assemble duct with no sheet metal screws, and no protrusions into the duct. All interior surfaces are to be smooth.
- B. All elbows are to be radius type.

- C. Provide 2 hour rated duct wrap or enclosure for all dryer exhaust ductwork from laundry room wall to exterior termination.
- D. Fire dampers are not allowed.

3.5 DUCT LEAKAGE TESTING

- A. Installed ductwork shall be tested prior to installation of access doors, take-offs, etc.
- B. All leak testing shall be witnessed by the Engineer or representative of the Engineer. The Contractor shall give the Engineer 72 hours' notice prior to testing. Any testing not witnessed by the Engineer or his/her representative, shall be considered invalid and will be redone.
- C. The testing shall be performed as follows:
 - 1. Perform testing in accordance with HVAC Air Duct Leakage Test Manual.
 - 2. Use a certified orifice tube for measuring the leakage.
 - 3. Define section of system to be tested and blank off.
 - 4. Determine the percentage of the system being tested.
 - 5. Using the percentage, determine the allowable leakage (cfm) for that section being tested.
 - 6. Pressurize to operating pressure and repair any significant or audible leaks.
 - 7. Repressurize and measure leakage.
 - 8. Repeat steps 6 and 7 until the leakage measured is less than the allowable defined in step 5.
- D. All transverse joints and longitudinal seams shall conform to SMACNA's Class A sealing requirements as defined on page 1.17 of the 2005 SMACNA Manual, Third Edition.
- E. Constant Volume Systems/Supply Ductwork
Allowable Leakage 1% of design cfm
- F. Constant Volume Systems/Return Ductwork
Allowable Leakage 2% of design cfm
- G. Variable Air Volume Systems/Supply Ductwork
Fan to VAV Boxes 1% of design cfm
VAV Boxes to Registers 2% of design cfm
- H. Variable Air Volume Systems/Return Ductwork
Allowable Leakage 2% of design cfm
- I. Exhaust Systems 1% of design cfm

J. Extent of Testing

1. Test all sheet metal located within shaft wall construction or concealed behind walls.
2. Test the first 25 percent of duct area of each individual fan system on the project. Testing shall begin at the supply fan or air handling unit discharge for supply air systems or at the exhaust fan or return fan intake for exhaust or return air systems. If all individual fan systems show leakage levels at or below those listed above, remaining ductwork will be permitted to be visually inspected.
3. At Engineer's discretion up to 5 additional tests at random system points may be required.
4. Submit duct testing reports for each individual fan system to Engineer for record.
5. Refer to Section 23 09 03 for additional requirements.

3.6 DUCTWORK STORAGE AND CLEANING

A. Cleaning:

1. Interior surfaces shall be free of dust and debris prior to initial startup. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes. Any cleaning of duct systems shall comply with recommendations of NAIMA and NADCA.
2. When internally cleaning duct work prior to installation or shipment to the jobsite, all duct ends and openings must be covered prior to transporting with a dual Polyethylene protective film. Film must be securely affixed to protect against dirt and debris and must be translucent to facilitate inspection of interior surfaces without removing film. Film must have a minimum elongation of 600%, contain no VOC and leave no residue on duct after removal.
3. Clean external surfaces of foreign substances that might cause corrosion, deterioration of the metal, or where ductwork is to be painted.

B. Protection:

1. Store duct a minimum of 4" above ground or floor to avoid damage from weather or spills.
2. Cover all stored ducts to protect from moisture or debris.
3. Cover all ends of installed ductwork at the end of each workday or when dust and debris producing construction (such as fire proofing, drywall, sanding, or core drilling) is occurring.

C. Ductwork contaminated or damaged above "shop" or "mill" conditions shall be cleaned, repaired or replaced to the Engineer's satisfaction.

1. Ductliner pre-installed in stored duct which has become wet may be installed if first allowed to completely dry out.
2. Ductliner in installed ductwork, which has become wet must be completely removed and replaced.

3. Torn ductliner may be replaced by coating with adhesive if damaged is minor and isolated. Extensively damaged liner shall be replaced back to a straight cut joint.

END OF SECTION 23 31 13

SECTION 23 33 00 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 INDUSTRY STANDARDS

- A. Comply with SMACNA (Sheet Metal and Air Conditioning Contractors' National Association) latest recommendations for fabrication, construction and details, and installation procedures, except as otherwise indicated.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's product data on the following:
 - 1. Flexible duct
 - 2. Ceiling dampers
 - 3. Fire dampers
 - 4. Smoke dampers
 - 5. Louvers
 - 6. Louvered penthouses
 - 7. Roof-mounted intakes
 - 8. Roof-mounted reliefs
 - 9. Gravity relief dampers
 - 10. Sound attenuators

PART 2 - PRODUCTS

2.1 FLEXIBLE DUCT ACOUSTICAL

- A. Manufacturers:
 - 1. Flexmaster Type 1M.
 - 2. ThermaFlex-MKE
- B. Construction:
 - 1. PE Liner film mechanically locked without adhesives.
 - 2. Insulation: Minimum 1-1/2" thick fiberglass blanket with a polyethylene vapor barrier. Map 0.23 'c' factor, factory installed.
 - 3. Helix: Corrosion resistant galvanized steel.
- C. Pressure rating: 5" w.g. positive, 1" w.g. negative at maximum 180°F operating temperature.

D. Standards: NFPA90A UL-181, Class I, ASTM E-96 - Procedure A.

E. Insertion loss shall be at least:

	OCTAVE BAND (Hz)					
Duct Size	125	250	500	1000	2000	4000
8"	5.6	10.6	23.9	34.0	22.5	17.0
12"	6.6	27.8	22.8	29.0	18.7	10.9
	DB reduction for 6-foot length, straight route, 500 fpm.					

2.2 FLEXIBLE DUCT, HIGH PRESSURE

A. Manufacturers:

1. American/Elgen
2. Flexmaster Type 3
3. Genflex, IGE
4. Thermaflex, MKC

B. Construction:

1. Insulated: Reinforced inner liner, mechanically locked or bonded together by a corrosive resistant galvanized steel helix, Min. 1-1/2" thick fiberglass blanket with polyethylene vapor barrier. Max. 0.23 'c' factor.
2. Uninsulated: Mechanically locked without adhesives with a corrosion resistant galvanized steel helix.
3. Aluminum: Mechanical lock without adhesives.

C. Pressure rating: 12" w.g. positive, 1" w.g. negative at 180°F.

D. Standards: NFPA90A, UL-181 Class I, ASTM E96 - Procedure A.

2.3 LOUVERS

A. Louvers are specified in the Architectural Division. This division is responsible for coordinating all duct connections, damper sizes, etc. with the louvers specified. Where louvers are not specified under architectural divisions, use the following.

B. Manufacturers:

1. Air Balance
2. Airolite
3. Arrow United Industries
4. AWV
5. Construction Specialties

6. Greenheck
7. Louvers & Dampers, Inc.
8. Pottorff
9. Ruskin
10. Safe-Air Dowco
11. United Enertech
12. Wonder Metals

C. Screens: ½” mesh, .063” aluminum wire.

D. Blades: Of depth shown by schedule, drainable.

E. Rating Basis:

1. AMCA Standard 500, based on 15-minute test of 48” x 48” louver. Provide louvers with water penetration and pressure drop no greater than specified louver, and with free area no less than specified louver.

2.4 PREFABRICATED CURBS

A. General: Except where curbs are provided with equipment, provide prefabricated curbs for all roof-mounted equipment.

B. Manufacturers:

1. Pace
2. RPS
3. Thycurb

C. Model for grease-laden exhaust fans: ES-2.

1. Coordinate to fit vibration isolation rail.

D. Coordinate with roofing Contractor. Exterior insulation, cants, flashing and counter flashing shall be furnished and installed under roofing work, Division 7.

E. Model: As required.

2.5 SOUND ATTENUATORS

A. Manufacturers:

1. Aerosonics
2. IAC Acoustics
3. Kinetics
4. Pottorff

5. Ruskin
6. Semco
7. Vibro Acoustics

B. Acoustical Performance

1. All duct silencer performance data shall be derived from National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory tests in accordance with ASTM E477-99, Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers. Submit certification of acoustical and aerodynamic performance.

2.6 FIRE DAMPERS

A. Manufacturers:

1. Air Balance
2. Greenheck
3. Johnson Controls
4. Nailor
5. NCA
6. Pottorff
7. Prefco
8. Ruskin
9. Safe-Air Dowco
10. United Enertech

B. Rating: UL555 dynamic 1-½ hours, or 3 hours, UL555S Class II leakage rated. Match construction penetrated.

C. Size: Metal-to-metal for lined and unlined ducts.

D. For curtain type, use Type B “Top Hat” wherever possible.

E. Integral factory-mounted access door.

2.7 FIRE/SMOKE DAMPERS

A. Manufacturers:

1. Air Balance
2. Greenheck
3. Johnson Controls
4. Nailor
5. NCA

6. Pottorff
7. Prefco
8. Ruskin
9. Safe-Air Dowco
10. United Enertech

- B. Fire Damper Rating: UL Standard 555 Dynamic, 1-½ hour or 3 hours.
- C. Smoke Damper Rating: UL Standard 555S, Class II.
- D. Damper Assembly:
1. Type: 120-Volt.
 2. Listing: UL 555S, UL555.
 3. Rating: Match wall rating.
 4. Failure Position: Fail closed.
 5. Heat Sensor: 165°F heat sensor.
 6. Blade: Air foil.
 7. Seals: Mechanically fastened, rated up to 450°F.
 8. Integral factory-mounted access door.

2.8 SMOKE DAMPERS

- A. Manufacturers:
1. Air Balance
 2. Greenheck
 3. Johnson Controls
 4. Nailor
 5. NCA
 6. Pottorff
 7. Prefco
 8. Ruskin
 9. Safe-Air Dowco
 10. United Enertech
- B. Smoke Damper Rating: UL Standard 555S, Class II.
- C. Operator:
1. Type: 120-Volt.
 2. Listing: UL Smoke Damper Operator Label.
 3. Failure Position:
 - a. Smoke control system dampers: As shown on plans.
 - b. Others: Closed

- D. Blade: Air foil.
- E. Seals: Steel.
- F. Integral factory-mounted access door.

2.9 GREASE DUCT DAMPERS

- A. Manufacturers:
 - 1. Halton
 - 2. Provide submittal for prior approval.
- B. Model: The Equalizer KBD
- C. Rating: UL listed for Type I hood systems.

2.10 MISCELLANEOUS DUCTWORK ACCESSORIES

- A. Duct Access Doors: Provide duct access doors with gaskets, door hinge, and with insulation where ductwork is indicated to be insulated.
 - 1. Manufacturers:
 - a. Greenheck
 - b. Ductmate
 - c. Elmdor
 - d. Flexmaster
 - e. Milcor
- B. Flexible Connectors:
 - 1. Manufacturers:
 - a. Cain Thermolon
 - b. Carlisle Connector Plus w/Silicone Hi-T
 - c. Duro-Dyne Thermafab
 - d. Ductmate PROFlex with Silicone
 - 2. Material: Glass fabric with silicone coating.
 - 3. Rating: ASTM E84 or UL 723
 - a. ASTM E84
 - 1) Flame Spread less than 25
 - 2) Smoke Developed less than 50

2.11 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers:

1. Greenheck
2. Nailor
3. Pottorff
4. Ruskin
5. Safe-Air Dowco
6. United Enertech

B. Construction:

1. Frame: Extruded aluminum.
2. Blades: Formed aluminum with extruded vinyl edge seals.
3. Bearings: Synthetic
4. Downflow: Provide gravity type counter-balanced damper with zinc plated steel weights
5. Upflow or Horizontal Flow: Provide gravity type damper with or without zinc plated steel weights

C. Performance: 12 cfm per square foot at ½" W.G.

2.12 BALANCING DAMPERS

A. Construction:

1. Frame: 16-gauge galvanized steel.
2. Blades: 16-gauge galvanized steel with vinyl edge seals.
3. Bearings: Heavy duty nylon.
4. Performance:
 - a. Maximum pressure drop in full open position (@3000 fpm): 0.55
 - b. Maximum leakage: 32 cfm/sp at 4" W.C.

B. Type: Rectangular balancing dampers are to be opposed blade type with locking handle, unless otherwise noted.

PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESSORIES

- #### **A.**
- Install fire, smoke and ceiling dampers in accordance with manufacturer's instructions and the latest version of the Fire, Smoke and Radiation Damper Guide for HVAC Systems, published by SMACNA.

- B. Install access doors where necessary for inspection and maintenance.
 - 1. Provide additional 12" x 12" access door at each low leakage damper.
 - 2. Arrange access doors so that:
 - a. They open against the system air pressure, wherever feasible.
 - b. Their latches are operable from either side, except where the duct is too small to be entered.
 - c. Install flexible connectors at all duct connections to rotating or reciprocating machinery or equipment.
 - 3. Provide access doors at all fire damper locations.
- C. Use HIGH PRESSURE flexible duct where shown upstream of VAV boxes.
- D. Notify fire alarm provider of smoke damper control requirements and fire alarm interlocks.
- E. Install flexible ductwork without tight bends and free of kinks.
 - 1. Flexible ductwork shall not be less than 4', nor exceed 8' in length.
 - 2. Flexible ductwork shall be installed with a "minimum length of straight duct" upstream of the diffuser neck inlet. "A minimum length" shall mean a length equal to three (3) duct diameters. "Straight duct" shall mean the center-line of the duct shall be aligned with a line perpendicular to the plane of the diffuser neck opening at the center point of the opening.
 - 3. Conform to the detail on the drawings.
- F. Install all dampers, including those furnished by Section 23 09 00 Contractor.
 - 1. Caulk damper frames to ductwork.
 - 2. Make sure dampers are free to operate properly.
 - 3. Install parallel blade mixing dampers to two streams impinge on each other to facilitate mixing.
- G. Provide balance dampers at branch take-off and where required to minimize balancing performed at diffuser face.
- H. Provide all balance dampers as shown on plans and any additional dampers necessary to provide a balanced system meeting all sound requirements.

END OF SECTION 23 33 00

SECTION 23 34 00 - FANS

PART 1 - GENERAL

1.1 QUALITY CONTROL

- A. Provide fans with AMCA performance certification and label.
- A. Grease exhaust fan shall comply with NFPA 96 and be UL listed.
- B. Fans serving dishwashers shall be UL listed and appropriate for moisture laden air application.
- C. All fans 7.5 HP and below to be provided with an adjustable pulley to accommodate proper balancing.
- D. All spun-aluminum fans to be provided with a belt tensioner and a two-section motor cover allowing access to motor and belts without the use of tools.

1.2 MOTOR HORSEPOWER

- A. Do not increase or decrease motor horsepower from that specified without written approval from Architect/Engineer. See Section 23 05 01.

1.3 SUBMITTALS

- A. Manufacturer's Data: Submit manufacturer's product data including:
 - 1. Performance
 - 2. Size
 - 3. Type
 - 4. Options provided
 - 5. Fan curves
 - 6. Indicate Compliance with Section 1.1 where applicable.

PART 2 - PRODUCTS

2.1 CABINET FAN

A. Manufacturers:

1. Acme
2. Aerovent
3. Carnes
4. Cook
5. Greenheck
6. New York Blower
7. PennBarry
8. Twin City

B. Features:

1. Steel cabinet, acoustically insulated
2. Centrifugal wheel
3. Integral backdraft damper

C. Accessories:

1. Provide rheostatic speed controller for all direct drive fans. Mount under grille or on wall as specified in the drawings.

2.2 IN-LINE CENTRIFUGAL FAN

A. Manufacturers:

1. Acme
2. Aerovent
3. Carnes
4. Cook
5. Greenheck
6. New York Blower
7. PennBarry
8. Twin City

B. Features:

1. Steel cabinet, baked enamel finish
2. Cast aluminum wheel, statically and dynamically balanced
3. Cast aluminum hub
4. Heavy duty pillow block bearings within fan housing with external grease fittings

5. Belt guard
6. Drive: See schedule

C. Accessories:

1. Access panel.

2.3 IN-LINE MIXED FLOW FAN

A. Manufacturers:

1. Acme
2. Aerovent
3. Carnes
4. Cook
5. Greenheck
6. New York Blower
7. PennBarry
8. Twin City

B. Features:

1. Steel cabinet, baked enamel finish
2. Mixed flow wheel, statically and dynamically balanced
3. Hub keyed to shaft
4. Heavy duty pillow block bearings within fan housing with external grease fittings
5. Belt guard
6. Drive: See schedule

C. Accessories:

1. Access panel.

2.4 BELTED VENTILATING SETS (UTILITY FANS)

A. Manufacturers:

1. Acme
2. Aerovent
3. Carnes
4. Cook
5. Greenheck
6. New York Blower
7. PennBarry
8. Twin City

9. Design Basis: Twin City.
10. Other Acceptable Manufacturers:
 - a. Ammerman
 - b. Barry
 - c. Cook
 - d. Greenheck
 - e. New York Blower
 - f. Trane
 - g. Twin City

B. Features:

1. Welded steel housing
2. Backward inclined fan wheel
3. Pillow block bearings, average life 200,000 hours
4. Adjustable V-belt drive

C. Accessories

1. For Outdoor Units: Motor weather cover.
2. For Indoor Units: Belt guard.

2.5 SIDEWALL PROPELLER FAN

A. Manufacturers:

1. Acme
2. Aerovent
3. Carnes
4. Cook
5. Greenheck
6. New York Blower
7. PennBarry
8. Twin City

B. Features:

1. Steel panel
2. Steel tube frame
3. Aluminum or welded steel wheel
4. Totally enclosed fan motor
5. Direct drive or belt drive as scheduled

PART 3 - EXECUTION

3.1 NOISE AND VIBRATION

- A. Ensure that fans are properly supported on vibration isolators. Reference Section 23 05 48 for Vibration Isolation Requirements.
- B. Ensure that flexible duct connections are properly made.
- C. Check fan for improper balance.
 - 1. Have fan re-balanced if necessary.
- D. Check for proper rotation.
- E. Check for unusual noise or vibration and correct as necessary.

3.2 ACCESS

- A. Provide for proper access to all parts of fan needing inspection or service with access doors in fan or ductwork.

3.3 INSTALLATION

- A. Install units level and plumb.
- B. Provide necessary auxiliary supporting steel.
- C. Mount motor and drives so belts run true.
- D. Provide necessary lubrication.
- E. Provide flexible duct connections on inlet and discharge.

3.4 CURBS

- A. Provide necessary dimensions and details so roof opening can be provided at the proper time.
- B. Coordinate delivery of curb with roofing contractor so project is not delayed.

- C. Provide a weatherproof installation:
 - 1. Seal all joints including, but not limited to:
 - a. Unit and curb.
 - b. Unit and ducts.

END OF SECTION 23 34 00

SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Variable volume terminal units.
- B. Variable volume regulators.
- C. Integral heating coils.
- D. Integral damper motor operators.
- E. Integral controls.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Section 23 09 00 - Controls and Instrumentation: Thermostats and control components.

1.3 REFERENCES

- A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- B. UL 181 - Factory-Made Air Ducts and Connectors.
- C. ARI 880 - Air Conditioning and Refrigeration Institute Standard Rating Conditions for Air Terminals.
- D. UL - Shutoff terminal must be UL listed as a Room Air Terminal.
- E. ASTM A 527 (Steel Sheet, Zinc Coated Galvanized)

1.4 SUBMITTALS

- A. Submit shop drawings and product data sheets indicating configuration, general assembly, and materials used in fabrication.
- B. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate air flow, static pressure, and radiated sound power levels (2nd through 7th octave bands) at design maximum operating

conditions. Also submit Radiated Sound NC values. Shall be calculated at design conditions with the following path attenuation credits:

CORRECTION TO OCTAVE BAND SOUND POWER VALUE						
	2	3	4	5	6	7
Env Adj	-3	-2	-1	-1	-1	-1
Mineral Fiber Ceiling Tile	-9	-10	-12	-14	-15	-15
Space Effect Factor	-10	-11	-12	-13	-13	-14

This transfer function represents modeling assumptions based on ARI 885-90.

- C. Submit manufacturer's installation instructions.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum ten years of experience.

1.6 WARRANTY

- A. Provide one year manufacturer's parts warranty.

PART 2 - PRODUCTS

2.1 SINGLE DUCT VAV BOXES

- A. Manufacturers:
1. Carrier
 2. Enviro-Tec
 3. Johnson Controls
 4. Krueger
 5. Metal Aire
 6. Nailor
 7. Price
 8. Siemens
 9. Titus
 10. Trane

B. Sound Criteria:

1. Conform to ARI 880 performance test standard.
2. Discharge Sound:
 - a. 0.2" SP: NC40
 - b. 1.0" SP: NC53
3. Radiated Sound:
 - a. 0.2" SP: NC27
 - b. 1.0" SP: NC41
4. Sound levels may be attained using attenuators, but pressure drop of attenuator must be included as part of unit pressure drop.
 - a. Units will discharge into lined or fiberglass ductwork, credit for which cannot be claimed in sound criteria.

C. Duct Connections:

1. Duct connections shown on drawing are minimum.
2. Units with larger connections may be used to meet pressure or sound requirements.
3. Flexible duct shall be same size as unit connection.

D. Construction:

1. Galvanized steel, 1/2" lining, conforming to UL181 and NFPA90A.
2. Maximum leakage not exceeding 1% design flow.

E. Heating Coils:

1. Refer to Section 23 82 16 coils.

F. Control:

1. Electronic, using velocity sensor, with compensation or correction for distorted flow at inlet.
2. Maximum and minimum volume controls shall be:
 - a. Factory set (with allowance for altitude of project).
 - b. Accurate within 10%.
3. Units shall be normally open with reversing relay for use with direct acting thermostat.
4. Provide electric motor.
5. Coordinate spring range with Automatic Temperature Control Section.
6. Coordinate controls on VAV units with control contractor.

2.2 SOUND PERFORMANCE

- A. Terminal units shall not exceed the scheduled sound criteria.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

END OF SECTION 23 36 00

SECTION 23 37 00 - AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.1 CEILING CONSTRUCTION

- A. Provide products compatible with ceiling construction.

1.2 SUBMITTALS

- A. Submit catalog data including throw, sound, pressure drop and physical dimensions.

1.3 INDUSTRY STANDARDS

- A. Provide products tested in accordance with ASHRAE 70-1991 150 Standard 5219, 150 Standard 3741.

PART 2 - PRODUCTS

2.1 GRILLES AND RECTANGULAR DIFFUSERS

- A. Manufacturers:
 - 1. Krueger
 - 2. Metal Aire
 - 3. Nailor
 - 4. Price
 - 5. Titus
- B. Material: Steel or aluminum except:
 - 1. Where noted otherwise.
 - 2. Where required otherwise for fire rating.
 - 3. Grilles and diffusers in locker rooms, showers and toilet rooms in locker rooms to be aluminum.
- C. Finish: Baked white enamel except where noted.
- D. Refer to the Drawings for required performance.
- E. Match frame and border types to ceiling system.

2.2 SLOT DIFFUSERS WITH FACTORY-SUPPLIED PLENUMS

- A. Manufacturers:
 - 1. Krueger
 - 2. Metal Aire
 - 3. Nailor
 - 4. Price
 - 5. Titus
- B. Material: Steel or aluminum except:
 - 1. Where noted otherwise.
 - 2. Required otherwise for fire rating.
- C. Finish: Baked white enamel except where noted.
- D. Inlet Size: Match duct size.
- E. Match frame and border types to ceiling system.

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to architectural reflected ceiling plan for exact locations and ceiling types.
- B. Provide all support and framing devices necessary.
- C. Exposed mounting screws:
 - 1. Use tamper proof screws in countersunk holes.
 - 2. Point screws to match frame.
- D. Fire Rated Ceilings:
 - 1. Provide insulation equivalent to ceiling construction above diffuser between ceiling opening and ceiling damper.
- E. Install security type devices in accordance with manufacturer's directions.

END OF SECTION 23 37 00

SECTION 23 40 00 - AIR CLEANING

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data including:

1. Media:
 - a. Description
 - b. Efficiency
 - c. Test method
2. Enclosure
3. Support requirements
4. Weight
5. Electrical data
6. Drawings showing dimensions

1.2 QUALITY CONTROL

A. All filters shall be listed as class II per UL Standard 900.

PART 2 - PRODUCTS

2.1 1" MERV 8 PANEL FILTERS

A. Manufacturers:

1. Air Guard Type DP/DP Max
2. American Air Filter PREpleat LPD
3. Camfil Aeropleat IV

B. Media and Performance:

1. Non-woven cotton/synthetic.
2. MERV 8 filter efficiency per ASHRAE Standard 52.2-2012.
3. Not less than 2.3 square feet of media area per square foot of filter face area.
4. Not more than 0.25" WG initial resistance at 500 FPM.
5. Capable of 1.0" WG final resistance.

C. Support

1. Wire grid media support to maintain radial pleats.
2. Beverage board frame and diagonal supports.

2.2 2" MERV 8 PANEL FILTERS

A. Maintenance:

1. Air Guard Type DP/DP Max
2. American Air Filter PrePleat 40 LPD
3. Camfil Farr 30/30

B. Media and Performance:

1. Non-woven cotton/synthetic
2. MERV 8 filter efficiency per ASHRAE Standard 52.2-2012.
3. Clean filter efficiency of 23% at one micron.
4. Not less than 2.5 square feet of media area per square foot of filter face area.
5. No more than 0.31" WG initial resistance at 500 FPM.
6. Capable of 1.0" WG final resistance.

C. Support

1. Welded wire grid to maintain radial pleats.
2. Beverage board frame and diagonal supports.

2.3 12" MERV 13 CARTRIDGE FILTERS

A. Manufacturers:

1. Air Guard VariPak
2. American Air Filter Varicel RF
3. Camfil Riga-Flo

B. Media and Performance:

1. Microfine glass media in a uniform high loft media blanket.
2. MERV 13 filter efficiency per ASHRAE Standard 52.2-2012.
3. Not more than 0.50" WG initial resistance at 500 FPM.
4. Capable of 1.5" WG final resistance.

C. Support

1. Rigid cartridge type.
2. Welded wire grid to maintain pleat shape.

3. Contour stabilizers to maintain pleat spacing.
4. Galvanized steel enclosure and diagonal supports.
5. Capable of withstanding 10" S.P. drop without noticeable distortion.

2.4 FILTER GAUGES

- A. Dwyer Magnehelic Series 2000.
- B. Provide mounting bracket, tubing, static pressure taps and vent valves.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate filter banks to allow for access and prevent interference or damage by other components such as dampers and humidifiers.
- B. Provide vertical and horizontal stiffening bars, blank offs, angle flashing as necessary to install built up filter banks in plenum. Gasket or caulk between frame members, flashings, and blank offs.
- C. Provide filter gauges to measure pressure drop of all filter banks with 2" MERV 8 or 12" MERV 13 filters.
- D. Contractor shall provide a filter replacement matrix schedule for each unit indicating size and filter type.
- E. Provide and install a clean set of filters in all equipment prior to turn over to owner and one spare filter for each unit. For units with multiple filters provide a spare filter for each type.

END OF SECTION 23 40 00

SECTION 23 51 00 - FLUE SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplemental Conditions of the Construction Contract and Division 1 Specification Sections (General Requirements), apply to this section.

1.2 SUBMITTALS

- A. Submit manufacturer's product data on:
 - 1. Double wall vent pipe specifications.
 - 2. Engineered, factory provided drawing of intended design and routing including all components and sizes.
 - a. Submit pressure drop calculation.

PART 2 - PRODUCTS

2.1 DOUBLE WALL GAS VENT – TYPE B

- A. Manufacturers:
 - 1. DuraVent
 - 2. Hart & Cooley
 - 3. Metal-Fab
 - 4. Selkirk
- B. Type B:
 - 1. Material:
 - a. Outer Wall: Galvanized steel.
 - b. Inner Wall: Aluminum.
 - 2. UL 441.

2.2 DOUBLE WALL PRESSURE STACK

A. Manufacturers:

1. DuraVent
2. Hart & Cooley
3. ICC Chimney
4. Jeremias
5. Metal-Fab
6. Schebler Chimney Systems
7. Selkirk

B. Type PS - Double wall, un-insulated pressure stack:

1. Material:
 - a. Outer Wall: Aluminized steel.
 - b. Inner Wall: Stainless steel.
2. Self-supporting pressure stack, with proper support fitting, to 10' above a roof.
3. UL listed for intended use.

C. Type IPS - Double wall, insulated pressure stack:

1. Material:
 - a. Outer Wall: Aluminized steel.
 - b. Insulation: 1" Fiber.
 - c. Inner Wall: Stainless steel.
2. Self-supporting, insulated pressure stack, with proper support fitting, to 10' above a roof.
3. UL listed for intended use.

2.3 CONDENSING FLUE GAS

A. Manufacturers:

1. DuraVent
2. Heatfab
3. ICC Chimney
4. Jeremias
5. Metal-Fab
6. Schebler Chimney Systems
7. Selkirk

- B. Type: DWSS:
 - 1. Material:
 - a. Outer Wall: 304 Stainless steel.
 - b. Insulation: 1.25" fiber insulated gap space.
 - c. Inner Wall: UL-1738 listed corrosion resistant high-grade stainless steel.
 - d. Pressure: Positive up to 3" wc, negative or neutral.
 - 2. Self-supporting, with proper support fitting, to 10' above a roof.
 - 3. UL listed for intended use and UL listed per UL1738.

PART 3 - EXECUTION

3.1 GENERAL

- A. Make all vent pipe from draft hood or appliance connection to vent cap double wall.
- B. Fittings:
 - 1. Use factory-made fittings for all changes in direction and connections, and for support and flashing.
- C. Accessories: Provide necessary:
 - 1. Thimbles
 - 2. Flashings
 - 3. Caps
 - 4. Support assemblies
 - 5. Elbows
 - 6. Tee
 - 7. Accessories recommended by manufacturer for complete installation.
- D. Stack Paint:
 - 1. Paint stack with 2 coats of heat resistant paint equivalent to series 4200-4300 Rust-O-Leum (by this Contractor). Color as selected by Architect.
- E. Use Type B for:
 - 1. All atmospheric domestic water heaters.
 - 2. Furnaces, unit heaters and make-up air units.

- F. Use Type PS for:
 - 1. Atmospheric and positive pressure boiler stack and breeching.
 - 2. Force draft water heaters.
- G. Use Type IPS for:
 - 1. Forced draft boiler stack and breeching.
- H. Use Type DWSS for any boiler or water heater requiring Class II or IV vent (condensing type equipment).
- I. Provide barometric dampers in accordance with manufacturers guidelines for all water heaters and boilers.
- J. Provide automatic dampers by vent system manufacturer for all common vented equipment applications. Automatic dampers shall be powered and wired to boiler control system.

END OF SECTION 23 51 00

SECTION 23 52 00 - BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplemental Conditions of the Construction Contract and Division 1 Specification Sections (General Requirements), apply to this Section.

1.2 QUALITY ASSURANCE

- A. ASME Code Symbol Stamps: Provide boilers and safety (pressure relief) valves complying with ASME Code and stamped with appropriate code symbols.
- B. Hydronics Institute Insignia: Provide cast-iron boilers, which have been I-B-R (Institute of Boiler and Radiator Manufacturers) performance rated and have affixed the I-B-R insignia of the Hydronics Institute.
- C. AGA Certification: Provide boiler of design certified by American Gas Association.
- D. Submittals:
 - 1. Submit manufacturer's product data.
- E. The burner and controls shall be UL listed for all ranges of firing rates, meet the requirements of CSD-1 at or above 401 MBH SL input firing rate, meet the requirements of GE GAP Insurance (formerly Industrial Risk Insurers (IRI)) and Factory Mutual (FM) at or above 2,501 MBH SL input firing rate, and NFPA 85 at or above 12,500 SL input firing rate. The above burner and control requirements and firing rates are for a single burner serving a single boiler.
- F. General Requirements for Boiler Suppliers:
 - 1. The Boiler Representative shall be an authorized representative of the Boiler manufacturer and shall have been actively engaged with this manufacturer and in this field of operation for not less than five years. The installing contractor or boiler supplier shall have a service department as a permanent and integral part of his company with 24-hour service available at all times. The contractor or boiler supplier's stocking warehouse shall be no more than 100 miles from the jobsite and stock standard replacement parts for the boiler.
 - 2. The entity responsible for boiler service during the warranty period and his 24 hour service phone number shall be specified in the O & M manual.

3. The boiler representative shall provide a factory trained and factory authorized representative to perform the following:
 - a. Verify proper installation of boiler.
 - b. Verify installation of boiler gas train.
 - c. Verify proper wiring of controls and for proper operation of the controls in accordance with the boiler listing, manufacturer's directions and Sequence of Operation given in Section 23 09 00.
 - d. Adjust firing and perform combustion test. Testing shall be performed at full load conditions. The equipment and instruments required to perform the tests must meet with the approval of the Engineer.
 - e. The above tests must be certified by the factory authorized representative performing the test.
 - f. Provide free inspection and adjustment of the burner installation for the full warranty period of the installation.
 - g. Adjust power burners to provide sea level output at the jobsite elevation.

1.3 REGULATORY REQUIREMENTS

- A. Comply with the requirements of all authorities having jurisdiction including but not limited to:
 1. State Boiler Inspector.
 2. Local Building Department.
 3. Owner's Insurance Carrier.
- B. Provide all gas train components, operating controls, safety controls, low water cut outs, and other components required for the occupancy of the building and the size of the boiler.

PART 2 - PRODUCTS

2.1 CONDENSING BOILER

- A. Manufacturers:
 1. Basis of Design: Lochinvar Crest
 2. Other Acceptable Manufacturers:
 - a. Aerco (Benchmark)
 - b. RBI (FlexCore)
 - c. Riello (Array)
 - d. Viessmann

B. Heat Exchanger Assembly:

1. The boiler shall have a fully welded 316L stainless steel interior with a carbon steel shell fire tube heat exchanger. There shall be a single pressure vessel. Fire Tube shall be of the Wave Fire Tube design and capable of transferring 16,000 to 20,000 Btu's per tube. A liquid impact die shall be used to form the Wave Fire Tube. There shall be no banding material, bolts, gaskets or "O" rings in the heat exchanger construction. The Wave Fire Tube shall be robotically welded to the tube sheets. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. Pressure drop shall be no greater than 6.5 psi at 180 gpm. The condensate collection basin shall be constructed of welded 316L stainless steel.

C. Ratings and Efficiency:

1. The boiler shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard for the U.S. and Canada. The boiler shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard and the minimum efficiency requirements of the latest edition of the AHRI BTS-2000 Standard as defined by the Department of Energy in 10 CFR Part 431. The boiler shall operate at a minimum of 96% thermal efficiency (models FB 2501 – FB 6001), at full fire as registered with AHRI. The registered combustion efficiency must be equal to or greater than the registered thermal efficiency. Boiler shall operate up to 98% thermal efficiency with return water temperatures at 70°F or below at 20°F temperature rise. The boiler shall be certified for indoor installation.

D. Construction and Trim:

1. The boiler shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. Two burner/flame observation ports shall be provided. The single burner shall be a premix design constructed of high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The boiler shall be supplied with two gas valves designed with negative pressure regulation and be equipped with a pulse width modulation blower system, to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The boiler shall operate in a safe condition with gas supply pressures as low as 4 inches of water column on Natural and as low as 8 inches of water column on Propane. The burner flame shall be ignited by direct spark ignition with flame monitoring via a flame sensor.

E. Controls and Electrical Power:

1. The boiler shall utilize a 24 VAC control circuit and components. The control system shall have a display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The boiler shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 75 psi; outlet

- water temperature sensor (dual thermistor); return water temperature sensor; outdoor air sensor, flue temperature sensor (dual thermistor); high and low gas pressure switches, low water cut off with manual reset, blocked drain switch and a condensate trap for the heat exchanger condensate drain.
2. The boiler shall feature the “SMART TOUCH™” control with CON-X-US which is standard and factory installed with an 8” liquid crystal touch screen display, password security, outdoor air reset, pump delay with freeze protection, pump exercise, ramp delay featuring six steps, domestic hot water prioritization with limiting capabilities and PC port connection. The boiler shall have alarm contacts for any failure, runtime contacts and data logging of runtime at given modulation rates, ignition attempts and ignition failures. The boiler shall have a built-in “Cascade” to sequence and rotate while maintaining modulation of up to eight boilers of different Btu inputs without utilization of an external controller. The internal “Cascade” function shall be capable of lead-lag, efficiency optimization, front-end loading, and rotation of lead boiler every 24 hours. The control must include cascade redundancy to allow a member boiler to become the temporary leader if the original lead boiler shall loose communication with the members. The boiler shall be capable of controlling an isolation valve (valve shall be provided by manufacturer) during heating operation and rotation of open valves in standby operation for full flow applications. The control must be equipped with standard BACnet MSTP and Modbus communication protocol with a minimum 55 readable points. The boiler shall have an optional gateway device which will allow integration with LON or BACnet (IP) protocols.
 3. The “SMART TOUCH™” control shall include CON-X-US communication platform that will allow remote access via a smart phone or Tablet. This will allow the ability to monitor and manage multiple boilers and send alerts via text or e-mail notifying of changes in system status. A user shall have the ability to check system status or re-program any boiler function remotely.
 4. The “SMART TOUCH™” control shall increase fan speed to boost flame signal when a weak flame signal is detected during normal operation. A 0 -10 VDC output signal shall control a variable speed boiler pump (pump to be offered by manufacturer) to keep a fixed delta t across the boiler regardless of the modulation rate. The boiler shall have the capability to receive a 0 – 10 VDC input signal from a variable speed system pump to anticipate changes in system heat load in order to prevent flow related issues and erratic temperature cycling.
 5. The boiler shall have RealTime O2 Feedback™. The O2 sensor shall be located in the combustion chamber. The feedback shall be in real time and displayed via a gauge on both the boiler touchscreen and the CON-X-US communication platform.
 6. The boiler shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 30 data points for safety and operating controls, i.e., Alarm Contacts, Runtime Contacts, Louver Proving Switch, Tank Thermostat, Remote Enable/Disable, System Supply Sensor, Outdoor Sensor, Tank Sensor, Modbus Building Management System signal and Cascade control circuit. A high voltage terminal strip shall be provided for Supply voltage. Supply voltage shall be 120V/1PH/60Hz (FB 751 – FB 2001), 208V/3PH/60Hz (FB 2501 – FB 3501), or 480V/3PH/60Hz (FB 4001 – FB 6001). The high voltage terminal strip plus integral relays are provided for independent pump control of the primary pump and secondary pumps.

F. Venting:

1. Boilers shall be common vented. The flue shall be Category II/IV approved Stainless Steel sealed vent only. The exhaust and air intake venting must use the exact diameter, length, placement, and terminations as specified by the boiler manufacturer. Boiler manufacturer shall submit common vent shop drawings to Engineer for review including duct sizes, pressure loss calculations, and terminations.

G. Altitude:

1. Project elevation is 6,700 feet. Submit rated de-rate for altitude.

H. Condensate Neutralization

1. Provide manufacturer's standard condensate neutralization system for each boiler. Pipe to indirect termination at floor drain in boiler room.

2.2 BREAK GLASS EPO SWITCH

- A. Provide break glass EPO switch at each boiler room door. Actuation of any EPO switch shall de-energize and shut off fuel supply to all gas-fired equipment within the room, including boilers, domestic water heaters, and other gas-fired equipment. Switch shall be installed by Division 26 Contractor.
- B. Where boiler room door opens to exterior, mount EPO switch on inside wall of boiler room near door.
- C. Where boiler room door opens to the building, mount EPO switch on wall outside of boiler room near boiler room entry door.

PART 3 - EXECUTION

3.1 FIELD ASSEMBLY

- A. Assemble boiler at the job site in an area designated by the Owner, convenient for installation.
- B. Comply with all manufacturers' requirements.
- C. Upon completion of assembly, contact Engineer and manufacturer's representative for field observation.

3.2 CLEANING

- A. Flush and clean boilers upon completion of installation in accordance with manufacturer's instruction.
- B. Include boiler in system for cleaning covered in Section 23 21 13.

3.3 FIELD QUALITY CONTROL

- A. Test assembled boiler, boiler piping and accessories, including, but not limited to, safety and safety relief valves, gauges, etc., in accordance with applicable sections of ASME Boiler and Pressure Vessel Code.
- B. Arrange with Owner's insurance carrier and State Boiler Inspector for inspection and certification of completed boiler unit.
- C. Instruct the Owner's Representative in the proper operation of the boiler in the presence of the Boiler Representative.

3.4 WATER QUALITY

- A. Initial fill of boiler water system shall be treated with softeners and/or inhibitors as recommended by Boiler Manufacturer.
- B. Submit a water quality analysis by a qualified water treatment company to Boiler Manufacturer for his use in recommending water treatment.
- C. Submit water quality analysis and treatment recommendations to Engineer for review and comment.

3.5 START UP

- A. Manufacturer representative shall provide factory trained personnel to start up and checkout boilers. Adjust burner to provide optimum combustion as determined from flue gas analysis.

END OF SECTION 23 52 00

SECTION 23 57 00 - HEAT EXCHANGERS

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

- A. ASME construction:
 - 1. Provide exchanger with ASME “U” stamp.
 - 2. Provide inspection certificate.
- B. Submittals: Submit manufacturer’s product data.
 - 1. Include the following:
 - a. Materials.
 - b. Design working pressure and temperature.
 - c. Entering and leaving conditions.
 - d. Fouling factors.
 - e. Flow rates.
 - f. Pressure drops.

PART 2 - PRODUCTS

2.1 PLATE TYPE HEAT EXCHANGERS

- A. Manufacturers:
 - 1. Alfa Laval
 - 2. Armstrong
 - 3. Bell and Gossett
 - 4. Mueller
 - 5. Taco
 - 6. Tranter
- B. Construction:
 - 1. Plates:
 - a. Stainless steel.
 - b. Minimum 0.5 mm thick.

2. Frames: Carbon steel.
 - a. Finish: Baked enamel.
3. Gaskets: Nitrile rubber.
4. Nozzles: 150 lb. Steel flanged.
5. Heat exchanger to be rated per AHRI 400 Standard if used in HVAC application.

PART 3 - EXECUTION

3.1 INSTALLATION OF PLATE TYPE HEAT EXCHANGERS

- A. Coordinate with piping arrangement so that plates may be removed.

END OF SECTION 23 57 00

SECTION 23 62 13 - AIR-COOLED CONDENSING UNITS

PART 1 - GENERAL

1.1 STANDARDS

A. Comply with applicable portions of the following:

1. Safety:
 - a. ANSI/ASHRAE 15.
 - b. UL 465.
2. Ratings: ARI 210.
3. Energy Efficiency: ASHRAE 90.
4. Sound: ARI 270.

1.2 SUBMITTALS

A. Submit manufacturer's data. Include the following:

1. Drawings showing:
 - a. Over-all dimensions.
 - b. Operating weights.
 - c. Support requirements.
 - d. Sizes and locations of connections.
 - e. Accessories.
2. Performance.
3. Wiring diagrams.
4. Installation instructions.
5. Operating instructions.
6. Service instructions.
7. Parts lists.

B. LEED Submittal:

1. Product data for refrigerants.
2. Weights and type of refrigerants.

PART 2 - PRODUCTS

2.1 RATINGS

- A. Based on sea level catalog ratings at 95° ambient.
- B. Where ratings are not shown in schedule, refer to cooling unit schedule.
 - 1. Allow two-degree suction line drop.

2.2 ELECTRICAL

- A. Refer to electrical plans and/or specifications for electrical characteristics.
- B. Provide equipment with ampacities not exceeding those of electrical circuits provided.
- C. Provide unit(s) for single point electrical connections.
- D. The electrical disconnect shall be provided under the electrical division.

2.3 CIRCUITS

- A. If more than the specified number of refrigerant circuits is provided, coordinate evaporator circuits for equal number of circuits.

2.4 MANUFACTURERS

- A. Manufacturers:
 - 1. Bohn
 - 2. Carrier
 - 3. Daikin Applied
 - 4. Dunham Bush
 - 5. Lennox
 - 6. Tempmaster
 - 7. Trane
 - 8. TSI
 - 9. York

2.5 CONSTRUCTION

- A. Casing: Welded, 18-gauge zinc-coated steel, with exterior phosphatized, primed with epoxy resin and finished with enamel.
 - 1. Provide removable access panels.
- B. Compressor: Hermetic or semi-hermetic with vibration isolators, crank case heater, suction pressure unloading.
- C. Condenser Fans: Vertical discharge, direct drive, with permanently lubricated resiliently-mounted motors with built-in overload protection.
 - 1. Provide fan guard.
- D. Condenser Coil: Copper tube, aluminum fins with sub-cooling circuit.
 - 1. Provide grille or louvers to protect coil from hail.
- E. Controls: Factory-wired, including:
 - 1. High and low pressurestats.
 - 2. Compressor overload devices.
 - 3. Short cycle timer.
 - 4. 24-Volt transformer.
- F. Capacity Control:
 - 1. Provide head pressure control for operation at minimum load at minimum specified temperature.
 - 2. Provide hot gas bypass for capacity between unloaded rating and minimum specified rating.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate condensing unit in general position indicated in relation to other work.
 - 1. Position for sufficient clearance for normal service and maintenance, including clearance for cleaning and replacement of tubes, filters, motor, etc.
- B. Charge with refrigerant in the quantity recommended by the manufacturer.
 - 1. Bleedout non-condensable gases.
 - 2. Test refrigerant system for leakage in manner recommended by manufacturer.

- C. Install pressure relief system in compliance with governing regulations, to vent refrigerant in manner indicated.
- D. Install refrigerant piping (Type ACR copper tube) in accordance with manufacturer's recommendations, and per the drawings.
 - 1. Comply with the Clean Air Act.
 - 2. Provide filter/dryer, site glass and service/isolation valves for each circuit.
 - 3. Run piping plumb. Slope as required for proper oil return and to protect compressor.
 - a. Provide oil trap at bottom of suction risers.
- E. Provide for vibration and expansion of piping.

3.2 START-UP

- A. Sustained Operation: Do not place unit in sustained operation prior to initial balancing of mechanical systems affected by unit operation.
- B. Cooperate with other trades and installers of other work during testing, adjusting, balancing and start-up of mechanical systems.
- C. Start up and first year parts and labor to be provided by equipment manufacturer.

END OF SECTION 23 62 13

SECTION 23 64 26 - AIR-COOLED WATER CHILLERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Chiller package.
- B. Charge of refrigerant and oil.
- C. Controls and control connections.
- D. Chilled water connections.
- E. Starters.
- F. Electrical power connections.

1.2 RELATED SECTIONS

- A. Section 23 23 00 - Refrigerant Piping.
- B. Section 23 09 00 –Building Automation and Automatic Temperature Control System.

1.3 REFERENCES

- A. AHRI 550/590 - Standard for Water Chilling Packages using the Vapor Compression Cycle
- B. AHRI 370 - Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
- C. ASHRAE 15 - Safety Code for Mechanical Refrigeration
- D. ASHRAE 90.1 - Energy Efficient Design of New Buildings
- E. ASME - Boiler and Pressure Vessel Code SEC VIII, Division 1
- F. UL 1995 - Central Cooling Air Conditioners
- G. ASTM B117 - Standard Method of Salt Spray (Fog) Testing
- H. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- I. ASTM A525 - Zinc (Hot-Dip Galvanized) Coatings on Sheet Steel Products

- J. ASTM D1654 - Evaluation of Painted or Coated Specimens, Subjected to Corrosive Environments
- K. ANSI/AFBMA 9-1978 - Load Ratings and Fatigue Life for Ball Bearings.

1.4 QUALITY ASSURANCE

- A. Factory Test: Chiller shall be pressure-tested, evacuated and fully charged with refrigerant and oil, and shall be factory operational run tested with water flowing through the vessel.
- B. Unit shall be delivered to job site fully assembled, and charged with refrigerant and oil by the Manufacturer. Cover unit with shrink wrapping or tarping to protect unit during shipping to the jobsite.
- C. Unit shall be stored and handled per Manufacturer's instructions.

1.5 SUBMITTALS

- A. Submit drawings indicating components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate accessories where required for complete system.
- B. Submit product data indicating rated capacities, weights, specialties, and accessories, electrical requirements and wiring diagrams.
- C. Submit manufacturer's installation instructions.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation data.
- B. Include start-up instructions, maintenance data, controls, and accessories.
- C. Submit maintenance data.

1.7 REGULATORY REQUIREMENTS

- A. Comply with codes and standards specified.
- B. Chiller must be built in an ISO 9001 classified facility.

1.8 STORAGE AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Protect units from physical damage. Factory coil shipping covers shall be kept in place until installation.
- C. Unit controls shall be capable of withstanding 203 Deg F (95 Deg C) storage temperatures in the control compartment for an indefinite period of time.

1.9 VERIFICATION OF CAPACITY AND EFFICIENCY

- A. All proposals for chiller performance must include an AHRI approved selection method. Verification of date and version of computer program selection or catalog is available through AHRI.

1.10 DELIVERY, HANDLING AND STORAGE

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting chillers.
- B. Chiller shall be capable of withstanding -40°F (-40°C) to 158°F (70°C) storage temperatures for an indefinite period of time.

1.11 WARRANTY

- A. Provide a full parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.
- B. Provide five-year warranty for replacement compressors.
- C. Provide one-year warranty for entire unit.

PART 2 - PRODUCTS

2.1 SUMMARY

- A. The contractor shall furnish and install air-cooled water chillers and shown as scheduled on the Contract Documents. The chillers shall be installed in accordance with this specification and perform at the specified conditions as scheduled. Equipment connections shall be limited to a single point electrical connection, a single chilled water supply and return connection and a

single condenser water supply and return connection. Any additional connections required for oil coolers, variable speed drives, etc. are not permitted.

2.2 APPROVED MANUFACTURERS

1. Basis of Design: Trane RTAF
2. Other Manufacturers:
 - a. Carrier
 - b. Daikin Applied
 - c. Quantech
 - d. York
3. Substitutions: Prior approval required as indicated under the general and/or supplemental conditions of these specifications.

2.3 GENERAL UNIT DESCRIPTION

- A. Provide factory assembled and tested outdoor air-cooled liquid chillers consisting of screw compressors, condenser, evaporator, thermal or electronic expansion valve, refrigeration accessories, starter and control panel. Construction and ratings shall be in accordance with ANSI/ARI 550/590.

2.4 CHILLER OPERATION

- A. Chiller shall be able to start and operate in ambient conditions down to -4°F to 130°F. Wide ambient operation is accomplished with factory installed and tested protection. If field installed wide ambient solution is used this shall be purchased and installed at contractor expense.
- B. Chiller shall be capable of operating with a leaving solution temperature range 40°F to 68°F (4.4 to 20°C) without glycol.
- C. Chiller shall be capable of starting up with 95°F (35°C) entering fluid temperature to the evaporator. Maximum water temperature that can be circulated with the Chiller not operating is 108°F (52°C)
- D. Chiller shall provide evaporator freeze protection and low limit control to avoid low evaporator refrigerant temperature trip-outs during critical periods of chiller operation. Whenever this control is in effect, the controller shall indicate that the chiller is in adaptive mode. If the condition exists for more than 30 seconds, a limit warning alarm relay shall energize.
- E. Rapid Restart™ after power restoration. The Chiller shall be capable of starting in 45 seconds.

2.5 COMPRESSORS

- A. Construct chiller using semi-hermetic, variable speed drive, helical rotary screw compressors.
- B. Provide compressor motor that is suction gas cooled with robust construction and system design protection.
- C. Provide oil lubrication system with oil charging valve and oil filter to ensure adequate lubrication during starting, stopping, and normal operation.
- D. Provide compressor heater to evaporate refrigerant returning to compressor during shut down. Energize heater when compressor is not operating.
- E. Provide compressor with automatic capacity reduction equipment consisting of capacity control via variable speed drive and/or slide valve. Compressor must start unloaded for soft start on motors.
- F. Chiller shall be capable of operation down to 15% load without hot gas bypass.

2.6 EVAPORATOR

- A. The evaporator shall be designed, tested, and stamped in accordance with ASME code for a refrigerant side working pressure of 200 psig. Waterside working pressure shall be 150 psig.
- B. Insulate the evaporator with a minimum of 0.75 inch (K=0.28) UV rated insulation. If the insulation is field installed, the additional money to cover material and installation costs in the field should be included in the bid.
- C. Evaporator heaters shall be factory installed and shall protect chiller down to -4°F (-20°C). Contractor shall wire separate power to energize heat tape and protect evaporator while chiller is disconnected from the main power.
- D. Provide shell and tube type evaporator, seamless or welded steel construction with cast iron or fabricated steel heads, seamless internally and externally finned copper tubes, roller expanded into tube sheets.
- E. Provide ability to remove evaporator tubes from either end of the heat exchanger.
- F. Evaporator shall have cleanable tubes
- G. Provide water drain connection, vent and fittings. Factory installed leaving water temperature control and low temperature cutout sensors.
- H. Water connections shall be grooved pipe.
- I. Proof of flow shall be provided by the equipment manufacturer, mechanically installed and electrically wired, at the factory of origin.

2.7 FANS

- A. Fans shall be dynamically balanced and direct driven.
- B. All condenser fan TEAO motors have permanently lubricated ball bearings and external overload protection.
- C. All condenser fans shall have drives to provide variable speed for optimized efficiency.

2.8 CONDENSER

- A. Construct condenser coils of microchannel all aluminum brazed fin construction. The condenser coils shall have an integral sub-cooling circuit and shall be designed for at least 350 psig working pressure. Leak tested at 1.5 times working pressure. Coils can be cleaned with high pressure water.
- B. Condenser coils shall be transverse design. If coils are not transverse design, provide coil protection for shipping.
- C. An aluminum microchannel heat exchanger shall be integrated within the chiller upstream of the evaporator. The chiller controller shall actuate water control valves to automatically modulate cooling capacity using free cooling, mechanical cooling, or a combination of the two based on building demand and outdoor air temperature. Free Cooling shall be factory installed and tested. Maximum pressure 90 psi.

2.9 ENCLOSURES/CHILLER CONSTRUCTION

- A. Chiller panels, base rails and control panels shall be finished with a baked on powder paint. Control panel doors shall have door stays.
- B. Mount starters and Terminal Blocks in a UL 1995 rated weatherproof panel provided with full opening access doors. If a circuit breaker is chosen, it should be a lockable, through-the-door type with an operating handle and clearly visible from outside of chiller indicating if power is on or off.
- C. The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B117.

2.10 CHILLER MOUNTED VARIABLE SPEED DRIVE (VFD)

- A. The water chiller shall be furnished with an air cooled variable speed drive (VSD) as shown on the drawings.

- B. The VSD efficiency shall be 97% or better at full speed and full load. Fundamental displacement power factor shall be a minimum of 0.96 at all loads for VSD. All other starters shall have a minimum displacement power factor of 0.85.
- C. Power semi-conductor and capacitor cooling shall be from a liquid or air cooled heatsink.
- D. Unit shall have a single point power connection.
- E. A molded case high fault interrupting capacity circuit breaker shall be factory pre-wired with terminal block power connections and equipped with a lockable external operator handle, making it available to disconnect the chiller from main power.
- F. A control power transformer shall be factory-installed and factory-wired to provide unit control power.
- G. Unit wiring shall run in liquid-tight conduit.
- H. High short circuit current rating (SCCR) of 65kA for 380V and 460V chillers with selection of high fault protection device.
- I. Customer wired 15 amp, 115-volt GFCI convenience outlet shall be factory mounted on the exterior of the control panel.

2.11 REFRIGERANT CIRCUIT

- A. All chillers shall have 2 refrigeration circuits, each with one or two (manifolded) compressor(s) on each circuit.
- B. Provide for refrigerant circuit:
 - 1. Liquid line shutoff valve
 - 2. Suction service valve
 - 3. Discharge service valve
 - 4. Filter (replaceable core type)
 - 5. Liquid line sight glass.
 - 6. Electronic expansion valve sized for maximum operating pressure
 - 7. Charging valve
 - 8. Discharge and oil line check valves
 - 9. High side pressure relief valve
 - 10. Integrated oil loss sensor

- C. Full operating charge of R134a and oil.
 - 1. Provide a fully convertible and compatible next generation low GWP refrigerant chiller.
 - 2. If the chiller cannot be factory supplied as a fully convertible and compatible next generation low GWP refrigerant chiller, then the contractor shall provide a field retrofit or a refrigerant guarantee.
- D. Full operating charge of R513A and oil.

2.12 CONTROLS

- A. A color, touch sensitive liquid crystal display (LCD) shall be unit mounted and a minimum of 7" diagonal. Animated graphical representations of chiller subsystem operation shall be used to enhance the user interface.
- B. Display shall consist of a menu driven interface with easy touch screen navigation to organized sub-system reports for compressor, evaporator, and motor information as well as associated diagnostics.
- C. The chiller control panel shall provide password protection of all setpoints
- D. The controller shall have the ability to display all primary sub-system operational parameters on dedicated trending graphs. The operator must be able to create up to 6 additional custom trend graphs, choosing up to 10 unique parameters for each graph to trend log data parameters simultaneously over an adjustable period and frequency polling.
- E. Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chiller by the chiller manufacturer.
- F. The front of the chiller control panel shall display the following in clear language, without the use of codes, look-up tables, or gauges:
 - 1. Run time.
 - 2. Number of starts.
 - 3. Current chiller operating mode.
 - 4. Chilled water set point and set point source.
 - 5. Electrical current limit set point and set point source.
 - 6. Entering and leaving evaporator water temperatures.
 - 7. Saturated evaporator and condenser refrigerant temperatures.
 - 8. Evaporator and condenser refrigerant pressure.
 - 9. Oil tank pressure.
 - 10. Differential oil pressure.
 - 11. Compressor motor current per phase.
 - 12. Compressor motor percent RLA.

13. Compressor motor voltage per phase.
 14. Phase reversal/unbalance/single phasing and over/under voltage protection.
 15. Low chilled water temperature protection.
 16. High and low refrigerant pressure protection.
 17. Load limit thermostat to limit compressor loading on high return water temperature.
 18. Condenser fan sequencing to automatically cycle fans in response to load, expansion valve pressure, condenser pressure, and differential pressure to optimize chiller efficiency.
 19. Display diagnostics.
 20. Oil pressure control based off of maintaining system differential pressure.
 21. Compressors: Status (on/off), %RLA, anti-short cycle timer, and automatic compressor lead-lag.
 22. Oil loss indication.
- G. On chiller, mount weatherproof control panel, containing starters, power and control wiring, factory wired with terminal block power connection. Provide primary and secondary fused control power transformer.
- H. The chiller controller shall utilize a microprocessor that will automatically take action to prevent chiller shutdown due to abnormal operating conditions associated with: evaporator refrigerant temperature, high condensing pressure and motor current overload.
- I. Provide the following safety controls with indicating lights or diagnostic readouts.
1. Low chilled water temperature protection.
 2. High refrigerant pressure.
 3. Low oil flow protection.
 4. Loss of Oil diagnostic
 5. Loss of chilled water flow.
 6. Contact for remote emergency shutdown.
 7. Motor current overload.
 8. Phase reversal/unbalance/single phasing.
 9. Over/under voltage.
 10. Failure of water temperature sensor used by controller.
 11. Compressor status (on or off).
- J. Provide the following operating controls:
1. A variable method to control capacity in order to maintain leaving chilled water temperature based on PI algorithms. Five minute solid state anti-recycle timer to prevent compressor from short cycling. Compressor minimum stop-to-start time limit shall be 2 minutes. If a greater than 5 minute start-to-start, or greater than 2 minute stop-to-start timer is included, hot gas bypass shall be provided to insure accurate chilled water temperature control in light load applications.
 2. Chilled water pump output relay that closes when the chiller is given a signal to start.
 3. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance trip outs.

4. High ambient unloader pressure controller that unloads compressors to keep head pressure under control and help prevent high pressure nuisance trip outs on days when outside ambient is above design.
 5. Compressor current sensing unloader chiller that unloads compressors to help prevent current overload nuisance trip outs.
 6. Low ambient lockout control with adjustable setpoint.
 7. Condenser fan sequencing which adjusts the speed of all fans automatically in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing chiller efficiency.
- K. Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Provide user interface with a minimum of the following features:
1. Leaving chilled water setpoint adjustment from LCD input
 2. Entering and leaving chilled water temperature output
 3. Percent RLA output for each compressor
 4. Pressure output of condenser
 5. Pressure output of evaporator
 6. Ambient temperature output
 7. Voltage output
 8. Current limit setpoint adjustment from LCD input.
- L. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.

2.13 SOUND

- A. Acoustics: Manufacturer must provide both sound power and sound pressure data in decibels. Sound pressure data per AHRI 370 must be provided in 8 octave band format at full load. In addition, A-weighted sound pressure at 30 feet should be provided at 100%, 75%, 50% and 25% load points to identify the full operational noise envelope.
- B. If manufacturer cannot meet the noise levels, sound attenuation devices and/or barrier walls must be installed to meet this performance level.

2.14 ACCESSORIES

- A. Chiller shall ship with elastomeric isolators

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Align chiller package on steel or concrete foundations.
- C. Install units on vibration isolators.
- D. Connect to electrical service.
- E. Connect to chilled water piping.
- F. Arrange piping for easy dismantling to permit tube cleaning.
- G. Coordinate all required electrical connections with electrical contractor including:
 - 1. Single-point chiller connection
 - 2. 120v heat tape connection

3.2 MANUFACTURER'S FIELD SERVICES

- A. Supply service of factory trained representative for a period of 3 days to supervise testing, start-up, and instruction on operation and maintenance to Owner.
- B. Supply initial charge of refrigerant and oil.

END OF SECTION 23 64 26

SECTION 23 73 13 - ENERGY RECOVERY VENTILATORS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Indoor energy recovery air handling units.

1.2 RELATED WORK

- A. Section 23 05 13 – Motors and Starters.
- B. Section 23 05 30 – Electronic Speed Controllers.
- C. Section 23 40 00 – Air Cleaning.
- D. Section 23 82 16 – Coils.

1.3 REFERENCES

- A. AMCA Publication 99 - Standards Handbook.
- B. AMCA Publication 611 - Certified Ratings Program - Airflow Measurement Performance
- C. AMCA Standard 500-D - Laboratory Methods of Testing Dampers for Rating.
- D. ANSI/ABMA Standard 9 - Load Ratings and Fatigue Life for Ball Bearings.
- E. ANSI/AMCA Standard 204 - Balance Quality and Vibration Levels for Fans.
- F. ANSI/AMCA Standard 610 - Laboratory Methods of Testing Airflow Measuring Stations for Rating.
- G. ANSI/AHRI Standard 410 - Forced Circulation Air-Cooling and Air-Heating Coils.
- H. ANSI/AHRI Standard 430 - Central Station Air Handling Units.
- I. ANSI/AHRI Standard 1060 - Rating Air-To-Air Energy Recovery Ventilation Equipment
- J. ANSI/ASHRAE Standard 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- K. ANSI/ASHARE Standard 62.1 - Ventilation for Acceptable Indoor Air Quality.

- L. ANSI/ASHARE Standard 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- M. ANSI/NEMA MG 1 - Motors and Generators.
- N. ANSI/UL 900 - Standard for Safety Air Filter Units.
- O. AHRI Standard 260 - Sound rating of Ducted Air Moving and Conditioning Equipment.
- P. ASHRAE Standard 84 - Method of Testing Air-to-Air Heat Exchangers.
- Q. ASHRAE Standard 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.
- R. ASTM B117 - Standard Practice for Operation Salt Spray Apparatus.
- S. ASTM C1071 - Thermal and Acoustic Insulation (Mineral Fiber, Duct Lining Material).
- T. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Material and Facings.
- U. ASTM E477 - Standard Test Method for Measure Acoustical and Airflow Performance of Duct Liner
- V. NFPA 70 - National Electrical Code
- W. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilation Systems.
- X. UL 1995 - Standard for Safety Heating and Cooling Equipment

1.4 QUALITY ASSURANCE

- A. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with ARI 410.
- B. Air Handling Units: Product of manufacturer regularly engaged in production of components who issues complete catalog data on total product offering and whose products have been in satisfactory use in similar service for no less than 15 years.
- C. Airflow monitoring station: Certify airflow measurement station performance in accordance with AMCA 611.

1.5 SUBMITTALS

- A. Shop drawings shall indicate assembly, unit dimensions, required clearances, construction details, and field connection details. Indicate accessories where required for complete system.

- B. Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, and gauges and finishes of materials.
- C. Provide fan curves with specified operating point clearly plotted.
- D. Submit product data of filter media, filter performance data, filter assembly, and filter frames.
- E. Submit manufacturer's installation instructions.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.7 REGULATOR REQUIREMENTS

- A. Agency Listings/Certifications
 - 1. Unit shall be manufactured to conform to UL 1995 and shall be listed by either UL/CUL or ETL. Units shall be provided with listing agency label affixed to the unit. In the event the unit is not UL/CUL or ETL approved, the contractor shall, at his/her expense, provide for a field inspection by a UL/CUL or ETL representative to verify conformance. If necessary, contractor shall perform modifications to the unit to comply with UL/CUL or ETL as directed by the representative, at no additional expense to the owner.
 - 2. Air handling units with multiple direct drive plenum fans, or direct drive plenum fans incorporated with ECM style motors are outside the scope of AHRI 430. These fans however are rated in accordance with AHRI 430.
 - 3. Certify air handling units in accordance with AHRI Standard 430. Units shall be provided with certification label affixed to the unit. If air handling units are not certified or fans are not rated in accordance with AHRI Standard 430 contractor shall be responsible for expenses associated with testing of units after installation to verify performance of fan(s). Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the contractor.
 - 4. Certify air handling coils in accordance with AHRI Standard 410. Units shall be provided with certification label affixed to the unit. If air handling coils are not certified in accordance with AHRI Standard 410, contractor shall be responsible for expenses associated with testing of coils after installation to verify performance of coil(s). Any costs incurred to adjust coils to meet scheduled capacities shall be the sole responsibility of the contractor.
 - 5. Certify airflow monitoring stations are tested for differential pressure in accordance with AMCA 611 in an AMCA registered laboratory and comply with the requirements of the AMCA Certified Ratings Program. Airflow monitoring station shall be licensed to bear the AMCA Seal.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site with factory- installed and/or factory provided lifting lugs. Items to be shipped per manufacturer's standard requirement.
- B. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- C. Protect units from physical damage. Factory coil shipping covers shall be kept in place until installation.
- D. Store and protect products under provisions of Section 23 05 02 Basic Mechanical Requirements.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.10 EXTRA STOCK

- A. Provide one complete set of permanent filters.

1.11 WARRANTY

- A. AHU manufacturer shall provide, at no additional cost, a standard parts warranty that covers a period of one year from unit start-up or 18 months from shipment, whichever occurs first. This shall warrant that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Basis of Design: Trane
- B. Other Manufacturers:
 - 1. Carrier
 - 2. CES Group
 - 3. Daikin Applied
 - 4. Scott Springfield
 - 5. Trane

6. York Model
7. Substitutions: Prior approval required as indicated under the general and/or supplemental conditions of these specifications.

2.2 GENERAL

- A. Manufacturer must clearly define any exceptions made to the Plans and Specifications. Mechanical contractor is responsible for expenses that occur due to exceptions made.
- B. Unit layout and configuration shall be as defined in project plans and schedule.
- C. Manufacturer to provide a full perimeter integral base frame to raise all sections of the unit for proper trapping. Base frame shall either be bolted construction or welded construction. Refer to schedule for base height and construction type. Contractor will be responsible for providing a housekeeping pad when unit base frame is not of sufficient height to properly trap unit. Unit base frames not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel. Unit base height to be included in total height required for proper trap height.

2.3 CASING CONSTRUCTION

- A. Unit manufacturer shall ship unit in segments as specified by the contractor for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.
- B. Casing performance - Casing air leakage shall not exceed 1% of design airflow at the specified casing pressure.
- C. Air leakage shall be determined at a casing static pressure of 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.
- D. Under 55F supply air temperature and design conditions on the exterior of the unit of 81F dry bulb and 73F wet bulb, condensation shall not form on the casing exterior.
- E. Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8-inch w.g., whichever is less, and shall not exceed 0.0042 per inch of panel span (L/240).

- F. Floor panels shall be double-wall construction and designed to support a 300-lb load during maintenance activities and shall deflect no more than 0.0042 per inch of panel span.
- G. Unit casing panels shall be 2-inch double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior.
- H. Unit casing panels (roof, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 Hr*Ft²*°F/BTU.
- I. Unit casing panels (roof, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A.
- J. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.
- K. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.
- L. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.
- M. Traction enhancements shall be applied to the unit floor to improve the walking surface in those unit sections where the floor is fully accessible, and not impeded by internal structural or functional features.

2.4 ACCESS DOORS

- A. All doors shall be provided with a thermal break construction of door panel and door frame.
- B. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.
- C. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.
- D. Handle hardware shall be designed to prevent unintended closure.
- E. Access doors shall be hinged and removable without the use of specialized tools.
- F. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions.
- G. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.

- H. All doors shall be a 60-inch high when sufficient unit height is available, or the maximum height allowed by the unit height.
- I. Multiple door handles shall be provided for each latching point of the door necessary to maintain the specified air leakage integrity of the unit.
- J. Shatterproof window shall be provided in fan section access doors. Window shall either be single pane, or thermal dual pane. Window shall be capable of withstanding unit operating pressures and shall be safe for viewing rotating equipment operation.
- K. Test ports shall be supplied in access doors as defined in the unit schedule to facilitate the field commissioning by the test and balance contractor. Test ports shall not compromise the ASHRAE leakage class of the unit.

2.5 PRIMARY DRAIN PANS

- A. All cooling coil sections shall be provided with an insulated, double-wall, galvanized drain pan.
- B. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements. See section 2.07, paragraph F through H for specifications on intermediate drain pans between cooling coils.
- C. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
- D. All drain pan threaded connections shall be visible external to the unit. Threaded connections under the unit floor shall not be accepted.
- E. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2-inch beyond the base to ensure adequate room for field piping of condensate traps.
- F. The installing contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate.
- G. Coil support members inside the drain pan shall be of the same material as the drain pan and coil casing.

2.6 FANS – GENERAL

- A. Fan sections shall have a minimum of one hinged and latched access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components. Construct door(s) per Section 2.04.
- B. Provide fans of type as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans that are selected with inverter balancing shall first be dynamically balanced at design RPM. The fans then will be checked in the factory from 25% to 100% of design RPM to insure they are operating within vibration tolerance specifications, and that there are no resonant frequency issues throughout this operating range. Inverter balancing that requires lockout frequencies inputted into a variable frequency drive to in order to bypass resonant frequencies shall not be acceptable. If supplied in this manner by the unit manufacturer, the contractor will be responsible for rebalancing in the field after unit installation. Fans selected with inverter balancing shall have a maintenance free, circumferential conductive micro fiber shaft grounding ring installed on the fan motor to discharge shaft currents to ground.
- C. Belt-driven fans shall be provided with grease lubricated, self-aligning, anti-friction bearings selected for L-50 200,000-hour average life per ANSI/AFBMA Standard 9. Lubrication lines for both bearings shall be extended to the drive side of the AHU and rigidly attached to support bracket with zerk fittings. Lubrication lines shall be a clear, high-pressure, polymer to aid in visual inspection. If extended lubrication lines are not provided, manufacturer shall provide permanently lubricated bearing with engineering calculations for proof of bearing life.
- D. Direct drive plenum fans with integral frame motors, shall be mounted on isolation bases. Fan shall be dynamically balanced throughout the operating range to a BV-3 (0.20 in/s) per AMCA 204 test standard. Fan and motor shall be internally isolated with spring isolators. A flexible connection shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.
- E. Direct drive plenum fans provided with ECM motors shall be a nine-blade, single width, single inlet fan with high efficiency welded -aluminum impeller that is dynamically balanced as an assembly.
 - 1. Fan shall be maintenance free throughout its operating life.
 - 2. Fans shall be balanced to a G6.3 per AMCA 204. No vibration isolation base is necessary
 - 3. Access to motor and fan assembly though hinged access door must be provided. Access door shall be sized for removal of entire motor and fan assembly.

4. Motor shall contain integrated PID controller and accept a 0-10VDC input signal for variable speed control.
 5. Motorized impeller fans shall be rated in accordance with AHRI Standard 430.6. Motorized impeller fan section shall include expanded metal door guard(s) supplied on the access door(s) to the fan. Door guard is intended to deter unauthorized entry and incidental contact with rotating components.
- F. Fan airflow measurement systems shall be provided as indicated on the schedule and drawings to measure fan airflow directly or to measure differential pressure that can be used to calculate airflow. The accuracy of the devices shall be no worse than +/- 5 percent when operating within stable fan operating conditions. Devices shall not affect the submitted fan performance and acoustical levels. Devices that obstruct the fan inlet or outlet shall not be acceptable. Devices shall be connected to transducers with selectable 4-20 mA or 2-10 VDC output. Signal shall be proportional to air velocity.
- G. Each direct drive fan in a multiple-fan array shall be provided with integral back flow prevention: a backdraft damper that prohibits recirculation of air in the event a fan or multiple fans become disabled. Dampers are tested and rated based on AMCA Standard 500. Dampers to be heavy duty type capable of a maximum back pressure that exceeds the design total static pressure with minimal leakage. The dampers should have a minimal total effect on airflow performance, pressure drop when open, and system effect on the fan. The damper blades and frame shall be extruded aluminum with blade edge seals locked into the blade edge. Adhesive type seals are unacceptable. AHU manufacturer responsible for providing proper spacing upstream of dampers to ensure full, uniform airflow through upstream components. For units where the damper(s) are supplied at the jobsite, the installing contractor shall contract a certified TAB contractor to verify uniform airflow thru upstream components.

2.7 MOTOR(S), AND DRIVES(S)

- A. All motors and drives shall be factory-installed and run tested. All motors shall be installed on a slide base to permit adjustment of belt tension. Slide base shall be designed to accept all motor sizes offered by the air-handler manufacturer for that fan size to allow a motor change in the future, should airflow requirements change. Fan sections without factory-installed motors shall have motors field installed by the contractor. The contractor shall be responsible for all costs associated with installation of motor and drive, alignment of sheaves and belts, run testing of the motor, and balancing of the assembly.
- B. Motors shall meet or exceed all NEMA Standards Publication MG 1 - 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.
- C. Fan Motors shall be heavy duty, open drip-proof operable at 460 volts, 60Hz, 3-phase. If applicable, motor efficiency shall meet or exceed NEMA Premium efficiencies.

- D. Direct driven fans utilizing integral frame motors shall use 2-pole (3600 rpm), 4-pole (1800 rpm) or 6-pole (1200 rpm) motors, NEMA Design B, with Class B insulation capable to operate continuously at 104 deg F (40 deg C) without tripping overloads.
- E. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.

2.8 COILS

- A. Coils section header end panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.
- B. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.
- C. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.
- D. Construct coil casings of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.
- E. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.
- F. When two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. The intermediate drain pan shall be designed being of sufficient size to collect all condensation produced from the coil and sloped to promote positive drainage to eliminate stagnant water conditions. The intermediate drain pan shall be constructed of the same material as the sections primary drain pan.
- G. The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil.
- H. Intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The intermediate drain pan outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
- I. Coil shall have a flexible epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Coating process shall ensure complete coil

encapsulation and a uniform dry film thickness from 0.8 to 1.2 mil on all surface areas including fin edges. Corrosion durability shall be confirmed through testing to no less than 5,000 hours salt spray per ASTM B117.

J. Hydronic Coils

1. Supply and return header connections shall be clearly labeled on unit exterior such that direction of coil water-flow is counter to direction of unit air-flow.
2. Coils shall be proof-tested to 300 psig and leak-tested to 200 psig air pressure under water.
3. Headers shall be constructed of round copper pipe or cast iron.
4. Tubes shall be 1/2-inch .016 copper, with aluminum fins.
5. Hydronic coils shall be supplied with factory installed drain and vent piping to the unit exterior.

2.9 FILTERS

- A. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall have side access filter guides and access door(s) extending the full height of the casing to facilitate filter removal or front loading filter frames. Construct doors in accordance with Section 2.04. Provide fixed filter blockoffs as required to prevent air bypass around filters. Blockoffs shall not need to be removed during filter replacement. Filters to be of size, and quantity needed to maximize filter face area of each particular unit size.
- B. Filter type, MERV rating, and arrangement shall be provided as defined in project plans and schedule
- C. Manufacturer shall provide one set of startup filters.
- D. Each filter section shall be provided with a factory-installed, flush-mounted Dwyer dial-type differential pressure gauge piped to both sides of the filter to indicate status. Gauge shall maintain a +/- 5 percent accuracy within operating temperature limits of -20°F to 120°F. Filter sections consisting of pre- and post-filters shall have a gauge for each.

2.10 INDUSTRIAL DAMPERS

- A. All dampers shall be internally mounted. Dampers shall be premium ultra low leak and located as indicated on the schedule and plans. Blade arrangement shall be parallel blade for mixing applications and opposed blade for non-mixing applications. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 3 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Manufacturer shall submit brand and model of damper(s) being furnished.

- B. Airflow measuring stations shall be provided and located in the outside and/or return air paths to measure airflow. Airflow measuring stations shall be tested per AMCA Standard 611 and licensed to bear the AMCA Ratings Seal for airflow measurement performance. Integral control damper blades shall be provided as galvanized steel and housed in a galvanized steel frame. Leakage rate shall not exceed 4 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage.
1. The airflow measurement station shall measure up to 100 percent of the total outside air and/or return air. The airflow measurement station shall be capable of measuring down to 300 fpm. The airflow measuring device shall adjust for temperature variations. Output shall be provided from the station as a 2-10 VDC signal. Signal shall be proportional to air velocity. The accuracy of the measuring station shall be no greater than +/- 5 percent. Airflow measuring stations shall be mounted on the AHU interior.
 2. The installing contractor shall provide duct-mounted pleated media MERV 8 filtration upstream of airflow monitoring stations requiring air straightening vanes to prevent blockage of vanes. A filter access door shall be provided for filter replacement that does not degrade the specified duct leakage class. Duct-mounted filtration section with access door for filter removal shall be tested for compliance to specified duct leakage class on the schedule and plans.

2.11 DISCHARGE PLENUM SECTIONS

- A. Plenums shall be provided as indicated in the schedule and plans to efficiently turn air and provide acoustical attenuation. Discharge plenum opening types and sizes shall be scaled to meet pressure drop requirements scheduled and align with duct takeoffs.
- B. Discharge plenum panels shall include an acoustical liner where indicated in the schedule and plans to meet acoustical requirements. The liner shall be fabricated from perforated material to prevent corrosion and designed to completely encapsulate fiberglass insulation. The perforation spacing and hole size shall be such as to prevent insulation breakaway, flake off, or delamination when tested at 9000 fpm, in accordance with UL 181 or ASTM C1071. Insulation material must be resistant to fungi in accordance with ASTM C1338.

2.12 TOTAL ENERGY RECOVERY WHEEL SECTION

- A. Total energy recovery wheels shall be provided as indicated on the schedule and drawings. Wheels shall be integral parts of the AHUs and shall be sized per the ventilation requirement of the units. Additional outside air units, or other field assembled and ducted energy recovery devices, are not acceptable. Units shall be constructed with internal bypass dampers such that the pressure drop across the wheel does not increase during economizing.
- B. The air handling unit shall be certified by AHRI to contain a rotary energy recovery wheel certified to ANSI/AHRI Standard 1060 and bears the AHRI 1060 label. Performance characteristics of the energy wheel shall be provided as defined by AHRI 1060 definitions. The energy wheel shall be a total energy wheel, with the sensible and latent effectiveness reported

and within 5% of each other. The calculated total net effectiveness of the recovery wheel shall not be less than 70% when the specified ventilation flow rate equals the exhaust flow rate. Wheel face velocity and pressure drop shall not exceed performance as defined on schedule. The energy recovery cassette shall be an Underwriters Laboratories (UL) Recognized Component certified for mechanical, electrical, and fire safety in accordance with UL Standard 1812.

- C. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belts. The total energy recovery wheel shall incorporate a desiccant without the use of binders or adhesives, which may plug the desiccant aperture. The adsorbent shall not be applied as a glued on surface coating and not susceptible to erosion, abrasion, or delamination. Coated segments shall be washable using standard detergent or alkaline-based coil cleaners. The adsorbent shall be selected for its high affinity for water vapor and shall not dissolve or deliquesce in the presence of water or high humidity. The rim shall be continuous rolled stainless steel to form an even concentric circle to prevent leakage around the rim and to minimize wear of components. All diameter and perimeter seals shall be provided as part of the cassette assembly. Perimeter seals shall be self-adjusting; diameter seals shall be adjustable.
- D. Wheel drive motor shall be provided mounted in the cassette frame. Wheel drive motor shall be thermally protected and UL Component Recognized. Drive belts shall not require belt tensioner. On units that require drive belt tensioner for the wheel belt/motor assembly, the unit manufacturer shall provide at no additional charge to the customer a visual inspection every four months, and adjustment if necessary, of the recommended belt tension during the unit warranty period. Wheel motors shall be of the voltage, phase, frequency, and Hp indicated on the schedule and drawings.
- E. Wheel bearings shall be permanently sealed and lubricated and have a minimum L-10 life of 400,000 hours.
- F. Access doors shall be provided for the removal of wheel segments. Doors shall be located to allow access to the entire upstream and downstream face of each wheel. Adequate space and access shall be provided for energy wheel motor, bearing and belt removal.
- G. Energy recovery wheels shall be designed with variable effectiveness control, to vary the wheel's recovery capacity. Variable effective control shall be done by an internal bypass damper provided by the AHU Manufacturer. The wheel's variable effectiveness control shall have the ability to modulate the total energy recovery ability down to at least 40% of the initial recovery capacity.
- H. Frost prevention shall be achieved by outside air bypass. Frost set point temperatures based on the scheduled design air conditions shall be provided by the AHU Manufacturer. Winter design supply and exhaust air conditions leaving the energy wheel shall be provided by the AHU Manufacturer and shall include any de-rate in performance due to frost prevention measures.

- I. Control of energy wheels shall be incorporated and an integral part of the AHU control systems and shall be as described under the AHU control specifications. Secondary independent wheel controllers are not acceptable.
- J. Access doors shall be provided on all air entering and air leaving sides of wheel to allow for wheel maintenance, belt or motor removal. Access doors shall be constructed per Section 2.04.

2.13 VARIABLE FREQUENCY DRIVES (VFDs)

- A. Variable frequency drives shall be provided, mounted and wired by the AHU manufacturer as indicated on the schedule and drawings. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. The VFDs shall be UL listed. The listing shall allow mounting in plenum or other air handling compartments.
- B. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor derating.
- C. With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
- D. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
- E. The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL 508 certified for the building and assembly of option panels. Assembly of separate panels with options by a third-party is not acceptable. The appropriate UL stickers shall be applied to both the VFD and option panel, in the case where these are not contained in one panel.
- F. The VFD shall have DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFDs without DC link reactors shall provide a minimum 3% impedance line reactor.
- G. The VFDs full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.
- H. The VFD shall be able to provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without derating.

- I. An automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy savings.
- J. Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.
- K. An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test.
- L. Galvanic and/or optical isolation shall be provided between the VFDs power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete I/O shall include additional isolation modules.
- M. The VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.
- N. Protective Features
 - 1. Protection shall be provided against input transients, loss of AC line phase, output short circuit, output ground fault, overvoltage, undervoltage, VFD overtemperature and motor overtemperature. The VFD shall display all faults as words. Codes are not acceptable.
 - 2. The VFD shall be protected from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD shall continue to operate with reduced output with an input voltage as low as 164 V AC for 208/230 volt units, 313 V AC for 460 volt units, and 394 volts for 600 volts units.
 - 3. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
 - 4. The VFD package shall include semi-conductor rated input fuses to protect power components.
 - 5. To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Otherwise, the AHU manufacturer shall ensure that inverter rated motors are supplied.
 - 6. The VFD shall include a "signal loss detection" circuit to sense the loss of an analog input signal such as 4 to 20 mA or 2 to 10 V DC, and shall be programmable to react as desired in such an instance.
 - 7. The VFD shall function normally when the keypad is removed while the VFD is running and continue to follow remote commands. No warnings or alarms shall be issued as a result of removing the keypad.
 - 8. The VFD shall catch a rotating motor operating forward or reverse up to full speed.
 - 9. The VFD shall be rated for 100,000 amp interrupting capacity (AIC).

10. The VFD shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD shall identify which of the output phases is low or lost.
11. The VFD shall continue to operate without faulting until input voltage reaches 300 V AC on 208/230 volt units, 539 V AC on 460 volt units, and 690 volts on 600 volt units.

O. Interface Features

1. Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference. On units with bypass, a VFD/Off/Bypass selector switch shall be provided.
2. The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode.
3. The VFD shall provide digital manual speed control. Potentiometers are not acceptable.
4. A lockable, alphanumeric backlit display keypad shall be provided. The keypad shall be remotely mountable up to 10 feet away using standard 9-pin cable.
5. The keypads for all sizes of VFDs shall be identical and interchangeable.
6. To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFDs keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters.
7. The display shall be programmable to display in English, Spanish and French at a minimum.
8. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
9. A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD eliminating the need for macros.
10. The VFD shall include a standard EIA-485 communications port and capabilities to be connected at a future date to a Johnson Controls N2 Metasys or Siemens FLN system at no additional cost to the owner. The connection shall be software selectable by the user.
11. At a minimum, the following points shall be controlled and/or accessible:
 - a. VFD Start/Stop
 - b. Speed reference
 - c. Fault diagnostics
 - d. Meter points
12. Four additional Form C 230 volt programmable relays shall be available for field installation within the VFD
13. LonWorks® communication shall be available for factory or field installation within the VFD.
14. Two set-point control interfaces (PID control) shall be standard in the unit. The VFD shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
15. Floating point control interface shall be provided to increase/decrease speed in response to contact closures.

16. Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. VFDs unable to show these four displays simultaneously shall provide panel meters.
17. Sleep mode shall be provided to automatically stop the VFD when its speed drops below set sleep level for a specified time. The VFD shall automatically restart when the speed command exceeds the set wake level.
18. The sleep mode shall be functional in both follower mode and PID mode.
19. A run permissive circuit shall be provided to accept a system ready signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.
20. The following displays shall be accessible from the control panel in actual units: Reference Signal Value, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, DC Bus Voltage, VFD Temperature in degrees, and unit CFM.
21. The display shall be programmed to read in inches of water column (in-wg).
22. The VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.
23. If the temperature of the VFDs heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFDs heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.
24. The VFD shall have temperature-controlled cooling fans for quiet operation and minimized losses.
25. The VFD shall store in memory the last 10 faults and related operational data.
26. Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
27. Two programmable relay outputs, one Form C 240 V AC, one Form A 30 V AC, shall be provided for remote indication of VFD status.
28. Three programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include two voltage (0 to 10 V DC, 2 to 10 V DC) and one current (0 to 20 mA, 4 to 20 mA) input.
29. Two programmable 0 to 20 mA analog outputs shall be provided for indication of VFD status. These outputs shall be programmable for output speed, frequency, current and power. They shall also be programmable to provide a selected 24V DC status indication.
30. Under fire mode conditions, the VFD shall be able to be programmed to automatically default to a preset speed.

P. Adjustments

1. The VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning the VFD to the motor.
2. A minimum of sixteen preset speeds shall be provided.
3. Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of

these curves shall be automatically contoured to ensure no-trip acceleration and deceleration.

4. Four current limit settings shall be provided.
5. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit and inverter overload.
6. The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
7. An automatic on delay shall be selectable from 0 to 120 seconds.

Q. Service Conditions

1. VFDs shall provide full output in an ambient temperature from -10 to 50°C (14 to 104°F).
2. VFDs shall provide full output in a relative humidity from 0 to 95%, non-condensing.
3. VFDs shall provide full output up to 3,300 feet elevation without derating.
4. VFDs shall provide full output with an AC line voltage variation from -10 to +10% of nominal voltage.
5. No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

R. Warranty

1. The VFD shall be warranted by the manufacturer for a period of 42 months from date of shipment, or 36 months from start-up, whichever occurs first. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory-authorized on-site service.

2.14 FACTORY-INSTALLED MOTOR WIRE TERMINATION, VFD, AND COMBINATION STARTER/DISCONNECT ENCLOSURES

- A. VFDs shall be factory mounted on the drive side of the fan section. VFD may be mounted on the interior of the unit, accessible from the unit exterior through an access door, or on the casing exterior in a NEMA Type 1 enclosure for indoor units. If not mounted on the fan section due to NEC disconnect height limitations or serviceability constraints in the mechanical equipment room, VFD may be mounted in another location other than the fan.
- B. Any welds shall be properly finished with no rough edges. Enclosures shall house circuit breaker disconnects, bypass circuitry, Drive-OFF-Bypass switches, manual speed controls, and control transformers. VFDs and starter/disconnects shall have an external disconnect located on the outside of the access door.

2.15 MOTOR OVERLOAD PANEL FOR FAN ARRAYS

- A. A motor overload panel provides a single unit mounted UL508A listed control panel with all fans in an array pre-wired to it, such that one properly sized VFD may be field connected with

no additional provisions required for protection of the individual motors. The control panel enclosure will be mounted on the exterior of the fan section and will be NEMA type 1 for indoor units and NEMA type 4 for outdoor units. A single power distribution block shall be provided for connection of the field mounted VFD with one conductor per phase. An electronic motor overload protector with lockable manual isolation switch shall be provided for each motor in the array. Each motor in the array shall be independently grounded with a dedicated green conductor. A minimum of one open ground lug per fan plus one shall be provided for field use. Each motor overload protector shall be provided with an auxiliary contact and all auxiliary contacts will be wired in series to a terminal block for generic trip signaling. The panel will be rated for WYE power systems up to 600V.

2.16 FACTORY WIRING OF LIGHTS, VFDS, AND COMBINATION STARTERS/DISCONNECTS

- A. VFDS shall be wired per NEC, UL, and NFPA 90A requirements. Units with factory-mounted controls shall also include power wiring from the VFD or starter/disconnect control transformer to the control system transformers. Units with VFDS and factory-mounted controls shall have a binary start-stop signal and an analog speed signal wired from the direct digital controller to the VFD.
- B. All power wiring for voltages greater than 24V and traveling through multiple unit sections shall be contained in an enclosed, metal, power-wiring raceway or EMT. Sections less than 6-inch in length may be contained in FMC.
- C. After mounting and wiring of VFDS, on the AHUs, trained factory personnel shall ensure proper operation of each VFD, through a thorough factory test. Testing shall include a Hypot test of unit wiring to ensure that no weaknesses exist in wiring or motor. Each VFD shall be energized and the fan run to ensure the VFD will operate throughout the usable range of the drive and that the fan rotation is correct. Each VFD with bypass shall also be tested in the bypass position to ensure the bypass is operational.
- D. For fan motors not supplied with a factory mounted and wired starter or VFD, the unit manufacturer shall supply a 4 X 4 NEMA 4 junction box on the exterior of the fan section(s) with wiring, prewired to the fan motor, to allow for ease of field installation of a starter or VFD.
- E. On units provided with factory mounted and wired supply fan starter or VFD and DDC controls, the manufacturer shall provide a single point of power. Line-to-24v transformers shall be provided with sufficient vA to power the unit mounted controller and factory installed control points.

2.17 FACTORY-ENGINEERED AUTOMATIC TEMPERATURE CONTROLS

- A. Unit shall be provided with a factory wired, installed and tested unit controller, capable of standalone unit control, or tied into a building automation system through Bacnet

communication. All control points in unit shall be tested at the unit manufacturers facility prior to shipment.

- B. Damper actuators shall be selected, provided, and mounted by the AHU manufacturer on each damper. Actuators shall be of sufficient size and quantity to ensure complete damper operation. Actuators shall be direct coupled to minimize linkage.
- C. Differential pressure switches shall be provided by the AHU manufacturer. Pressure switches shall be factory installed across each filter bank for individual filters to monitor clean/dirty filter status.
- D. Differential pressure gauges shall be provided by the AHU manufacturer. Pressure gauges shall be factory installed across each filter bank for individual filters. The gauge shall be diaphragm-actuated dial type.
- E. A momentary push-button reset circuit using a double-pole low limit switch shall be provided by the AHU manufacturer. Low limits shall be factory engineered to maximize coil coverage. Capillary radius clips shall be used at low limit bends to ensure no crimping or wear of low limits. Low limits shall be wired to shut down the fan to protect the unit.
- F. Fan status switches shall be provided and mounted by the AHU manufacturer.
- G. A discharge temperature sensor shall be provided and mounted by the AHU manufacturer. Temperature sensors mounted within the AHU shall have sensor material selected to integrate with the BAS controller.
- H. Averaging temperature sensors shall be provided by the AHU manufacturer. Sensors shall be factory engineered to accurately measure mixed air temperatures. Capillary radius clips shall be used at capillary bends to ensure no crimping or wear of the tube. Temperature sensors mounted within the AHU shall have sensor material selected to integrate with the BAS controller.
- I. Duct static pressure switches shall be provided by the AHU manufacturer in the unit. Switches shall be piped in the field.
- J. Valves shall be provided by the AHU manufacturer. Valves shall be shipped from the valve manufacturer directly to the job site or Mechanical Contractor for installation. Electrical connections shall be provided on the valves and at the AHU coil section for field connection.

2.18 UNIT DDC CONTROLLER

- A. One programmable DDC controller shall be provided by the AHU manufacturer for each unit. Control of multiple units from a single controller is not acceptable. Each programmable DDC controller shall use the LonTalk protocol and shall be LonMark certified to ensure open communication with other open BASs. Complete communications and diagnostics including all AI, BI, AO, BO, set points and alarms shall only require a twisted pair of wires between the

unit controller and the BAS. Each unit controller shall be factory wired to the unit end devices. For indoor units, each controller shall have a user display touch screen for user interface. The display on indoor units shall be unit mounted in the factory. For outdoor units, one portable user display touch screen for user interface shall be provided for all controllers. Displays shall give user access to AHU status, set points and alarms.

- B. The programmable DDC controller and the control components shall be selected, mounted, wired and tested by the AHU manufacturer to ensure delivery of specified performance and to minimize jobsite startup time. Testing shall be performed to ensure wiring continuity between the controller and all devices, and to ensure proper operation of the end devices. DDC controllers shall be located on unit as indicated on the drawings.
- C. Factory mounted controller shall be preprogrammed at the factory to minimize startup delay of the unit(s) at the job site. Controller shall be programmed with manufactures preferred standard basic programming based on unit configuration and options. Any additional programming or custom programming shall be provided at the job site by the unit manufacturer or controls contractor.

2.19 FACTORY TESTING

- A. A factory air leakage test shall be performed to verify the air handling unit conforms to the specified air leakage requirement. The entire unit shall be tested at specified total unit static as selected and specified. Leakage shall be calculated by totaling all leakage either into or out of the unit casing. Leakage shall not exceed specified leakage amount. Air pressure and casing leakage shall be measured by a third party calibrated and certified apparatus. A written test report shall be prepared by the manufacturer and issued to the owner or owner representative.
- B. A factory unit deflection test shall be performed to verify the air handling unit does not exceed $L/240$ of the panel span at the specified total unit static as selected and specified. A written test report shall be prepared by the manufacturer and issued to the owner or owner representative.

PART 3 - EXECUTION

3.1 GENERAL

- A. Assemble and install in accordance with manufacturers written installation instructions and details on drawings.
- B. Coordinate duct, piping and electrical work so as to provide access to unit for maintenance and filter replacement and coil removal with minimum disturbance of piping.
- C. Prior to unit start-up all controls shall be installed and tested.

- D. Prior to initial start-up and for system testing install air filters to protect the unit and ductwork from dirt and debris. After the system has been tested and prior to turning the system over to the Owner, replace the pre-filters with new, clean filters as specified.
- E. Prior to turning the system over to the Owner, all damages incurred during shipping, storing and installing shall be repaired. These repairs shall be sufficient to bring the equipment back to the quality standards, equal to the original manufacturing standards. These repairs shall include but are not limited to repairing painted surfaces, dent removal, combing coil fins, repairing or replacing wet, sagging or torn insulation, etc.
- F. Pipe condensate full size to nearest floor drain. Provide trap 1" greater than fan static pressure.
- G. Install units with adequate clearances to access valves, open access doors fully, for coil pull and NEC clearances in front of disconnect switches.

END OF SECTION 23 73 13

SECTION 23 82 16 - AIR COILS

PART 1 - GENERAL

1.1 SAFETY STANDARDS

- A. Provide electric heating coil in compliance with the National Electric Code and listed by UL for zero clearance and so labeled.

1.2 CAPACITY RATINGS

- A. Hydronic Coils: Certified per ARI 410.

1.3 SUBMITTALS

- A. Submit manufacturer's product data including:
 - 1. Performance data.
 - 2. Accessories description
 - 3. Operating weight.
 - 4. Drawings showing:
 - a. Dimensions.
 - b. Sizes and locations of connections.
 - 5. Support requirement.

1.4 FACE VELOCITY

Unless otherwise noted, face velocities shall not exceed the following:

- A. Cooling Coils: 550 fpm.
- B. Heating Coils: 600 fpm. (except electric coils)

PART 2 - PRODUCTS

2.1 HYDRONIC COILS

A. Manufacturers:

1. Aerofin
2. Airtherm
3. Carrier
4. Colmac
5. Daikin Applied
6. Dunham Bush
7. Heatcraft
8. Nationwide Coils
9. York

2.2 HEATING COILS (HOT WATER)

A. Construction:

1. Tubes: Copper.
2. Fins: Aluminum.
3. Casing: 16-gauge galvanized steel.
4. Max. service conditions:
 - a. 200 psig.
 - b. 220⁰
5. Certified in accordance with ARI Standard 410.

2.3 COOLING COILS (CHILLED WATER)

A. Construction:

1. Tubes: Copper.
2. Fins: Aluminum.
3. Casing: 16-gauge galvanized steel.
4. Max.service conditions:
 - a. 200 psig.
 - b. 220⁰
5. Certified in accordance with ARI Standard 410.

2.4 REFRIGERATION COILS

- A. Designed to conform to ANSI-B9.1 Safety Code for mechanical refrigeration.
- B. Tubes: Copper.
- C. Fins: Aluminum.
- D. Distributors: Equalizing Type.
- E. Coils to be vertical split.
- F. Accessories:
 - 1. Distributor with hot gas bypass connection.
 - a. Thermal expansion valve.
 - b. Size per manufacturers requirements.
 - c. Insulate sensing bulb.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install coils level and plumb.
- B. Provide necessary auxiliary support.
- C. Adjust air flow switch for safe operation.
- D. Check and adjust all controls.
- E. Pipe condensate drain from cooling coils as shown on the drawings or to nearest floor drain or mop sink.
- F. Coordinate electrical requirements with Division 26 prior to ordering. Report any discrepancies to the Engineer for resolution.
- G. For multiple coil sections, extend all connections insulated through unit casing or ductwork to connection points outside of casing or ductwork. Provide reverse return piping arrangement.

END OF SECTION 23 82 16

SECTION 23 82 19 - FAN COIL UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Factory constructed vertical or horizontal Fan Coil Units.

1.2 RELATED WORK

- A. Section 23 05 13 – Motors and Starters
Section 23 05 30 – Electronic Speed Controllers
Section 23 09 00 – Automatic Temperature Controls
Section 23 40 00 – Air Cleaning
Section 23 82 16 – Coils

1.3 REFERENCES

- A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- B. SMACNA - HVAC Duct Construction Standards.

1.4 QUALITY ASSURANCE

- A. Fan Coil Units: Product of manufacturer regularly engaged in production of components that issues complete catalog data on total product offering.
- B. Fan Coil Units: Certify capacity, static pressure, fan speed, brake horsepower and selection procedures in accordance with ARI 430-89.
- C. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with ARI 410-87.

1.5 SUBMITTALS

- A. Submit as-built drawings and product data under provisions of Division 1.
- B. As-built drawings shall show unit configuration in direction of airflow, and shall indicate assembly and unit dimensions.

- C. Product data shall indicate dimensions, weights, capacities, fan performance, motor electrical characteristics, and finishes of materials.
- D. Submit product data of filter sizes and quantities, filter performance, and filter frames.
- E. Submit manufacturer's installation instructions under provisions of Division 1.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Division 1.
- B. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

PART 2 - PRODUCTS

2.1 BLOWER COIL FAN COILS (400 TO 4,000 CFM)

- A. Acceptable Manufacturers
 - 1. Carrier
 - 2. Daikin Applied
 - 3. Enviro-Tec
 - 4. First Company
 - 5. International Environmental
 - 6. Johnson Controls
 - 7. Magic Aire
 - 8. The Whalen Company
 - 9. Titus
 - 10. Trane Company
- B. Construction
 - 1. See drawings for unit configuration.
 - 2. 18-gauge galvanized steel.
 - 3. ABS or stainless-steel drain pan, positively sloped in every plane.
 - 4. Provide secondary drain pan where indicated.
 - 5. All parts exposed to moisture are to be galvanized.
 - 6. Insulate unit throughout with 1-½ LB closed cell foil faced insulation.

7. Motor access panels on either side of unit.
8. Mixing box with ½” extended drive rod, and low leakage dampers with edge seals. Mixing box to allow 100% economizer operation.

C. Filters

1. See drawings for filter efficiency.
2. Filter rack, sized to provide maximum of 500 fpm across filter.

D. Fan

1. Fan to be forward curved centrifugal blower.
2. Provide adjustable v-belt drive.
3. Fan shaft to be supported by heavy duty permanently sealed ball bearings.
4. Fan and housing are corrosion resistant.

E. Motor

1. Provide integral overload protection.
2. Motor to be permanently lubricated.
3. Fan Motors shall be heavy duty, high efficiency, and open drip-proof or electronically commutated where specified.
4. Motor horsepower shall not be changed without written approval from the Engineer.

F. Coils

1. Coils are leak tested at 350 PSIG minimum air pressure, suitable for working pressures up to 250 PSIG with air vents
2. Coils shall be designed with aluminum plate fins and copper tubes.
3. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Capacities, pressure drops and selection procedure shall be certified in accordance with ARI Standard 440.
4. Provide factory installed extended drain and vent connections for water coils.

2.2 HORIZONTAL OR VERTICAL CASED FAN COIL UNITS (300 TO 1300 CFM)

A. Acceptable Manufacturers

1. Carrier
2. Daikin Applied
3. Enviro-Tec
4. First Company
5. International Environmental
6. Johnson Controls
7. Magic Aire

8. The Whalen Company
9. Titus
10. Trane Company

B. Construction

1. See drawings for unit configuration.
2. 18-gauge galvanized steel.
3. For exposed units, provide baked powder finish in standard color. Color selection by architect.
4. ABS or stainless-steel drain pan, positively sloped in every plane.
5. Thermoplastic secondary drain pan.
6. All parts exposed to moisture are to be galvanized.
7. Insulate unit throughout with closed cell insulation.
8. Refrigerator style leveling feet for vertical units.
9. Provide piping end pocket.

C. Fan

1. Aluminum, direct drive fan wheel and sheet metal housing.
2. Fan wheel to be forward curved, double width.
3. Fan and housing are corrosion resistant.

D. Motor

1. Provide electronically commutated fan motor and integral overload protection.
2. Motor to be permanently lubricated.
3. Motor shall be able to start at 78 percent of rated voltage and operate at 90 percent of rated voltage on all speed settings.

E. Coils

1. Coils are leak tested at 350 PSIG minimum air pressure, suitable for working pressures up to 250 PSIG with air vents
2. Coils shall be designed with aluminum plate fins and copper tubes.
3. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Capacities, pressure drops and selection procedure shall be certified in accordance with ARI Standard 440.
4. Provide factory installed extended drain and vent connections for water coils.

PART 3 - EXECUTION

3.1 GENERAL

- A. Assemble and install in accordance with manufacturers written installation instructions and details on drawings.
- B. Coordinate duct, piping and electrical work so as to provide access to unit for maintenance and filter replacement and coil removal with minimum disturbance of piping and no demolition of room construction or finishes.
- C. Prior to unit start-up all controls shall be installed and tested.
- D. Prior to initial start-up and for system testing install air filters to protect the unit and ductwork from dirt and debris. After the system has been tested and prior to turning the system over to the Owner, replace the pre-filters with new, clean filters as specified.
- E. Prior to turning the system over to the Owner, all damages incurred during shipping, storing and installing shall be repaired. These repairs shall be sufficient to bring the equipment back to the quality standards, equal to the original manufacturing standards. These repairs shall include but are not limited to repairing painted surfaces, dent removal, combing coil fins, repairing or replacing wet, sagging or torn insulation, etc.
- F. Pipe condensate full size to nearest floor drain. Provide trap 1" greater than fan static pressure.
- G. Install units with adequate clearances as to:
 - 1. Allow access to valves
 - 2. Allow for coil pull, filter replacement and maintenance
 - 3. Allow access doors to fully open
 - 4. Provide required NEC clearances in front of disconnect and electrical components.

END OF SECTION 23 82 19

SECTION 23 82 39 - HEATING TERMINAL UNITS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data:

1. Performance data.
2. Drawings.
 - a. Dimensions
 - b. Support requirements
 - c. Size and location of connections
3. Enclosure gauges.
4. Accessories.
5. Parts lists.
6. Additional Submittal Requirements for Fan Coil Units, Cabinet Heaters and Unit Heaters:
 - a. Wiring diagrams.
 - b. Installation, operating and maintenance instructions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Except as otherwise indicated, provide manufacturer's standard products as indicated by published product information, and as required for a complete installation.

2.2 HYDRONIC PROPELLER UNIT HEATERS

A. Manufacturers:

1. Daikin Applied
2. Modine
3. Sterling
4. Trane
5. Vulcan
6. Zehnder Rittling

B. Construction:

1. Coils:

- a. Fins: Aluminum.
- b. Tubes: Copper, expanded into fins.
- c. Working Pressure: 250 psig.

2. Casing:

- a. Material: 18-gauge steel.
- b. Corners: Rounded, 1" minimum radius.
- c. Finish: Phosphatized and painted inside and out with one coat of baked-on enamel.
- d. Fan Orifice: Integral with casing.

3. Motors:

- a. Type: Totally enclosed, shaded pole or split capacitor.
- b. Insulation: Class B.
- c. Mount: Resilient.
- d. Bearings: Sleeve or permanently lubricated ball bearings.
- e. Protection: Built-in thermal overload.

4. Guards

- a. Provide wire guards over propeller fans.

2.3 HYDRONIC CABINET UNIT HEATERS

A. Manufacturers:

- 1. Daikin Applied
- 2. Modine
- 3. Sterling
- 4. Trane
- 5. Vulcan
- 6. Zehnder Rittling

B. Construction:

1. Coils:

- a. Fins: Aluminum.
- b. Tubes: Copper.
- c. Working Pressure: 250 psig.

2. Casing:
 - a. Material: 16-gauge steel.
 - b. Corners: Rounded, 1" minimum radius.
 - c. Finish: Phosphatized and painted inside and out with one coat of baked-on enamel.
 - d. Color: Selected by Architect/Engineer from manufacturer's standard colors.
 - e. Heating Element Supports: Adjustable.
 - f. Gaskets: Between front panel and enclosure.
3. Grilles: Fabricated steel bar grille.
 - a. Directional Louvers: Under grille.
4. Fans:
 - a. Arrangement: Blow-through
 - b. Type: Multi-wheel, DWDI, FC, aluminum.
 - c. Balance: Factory balance, static and dynamic.
 - d. Drive: Direct.
5. Motors:
 - a. Type: Shaded pole, permanently lubricated.
 - b. Insulation: Class B.
 - c. Speeds: Three.
 - d. Protection: Built-in thermal overload.
6. Filters: Disposable, ¾" or 1" thick.
7. Filters: Permanent.
 - a. Type: Permanent.
 - b. Material: Metal.
 - c. Thickness: 1"

2.4 HYDRONIC FINNED TUBE RADIATION

- A. Manufacturers:
 1. Modine
 2. Slant Fin
 3. Smith's Environmental Products
 4. Sterling
 5. Trane
 6. Vulcan
 7. Zehnder Rittling

- B. Provide with high pressure rating allowing for 125 PSI operating pressure.
- C. Heating Element: Provide heating elements consisting of copper tubes, mechanically expanded into aluminum fins.
 - 1. If tubing size is changed from that specified, adjust rating to allow for change in water velocity.
- D. Enclosure:
 - 1. Material: 14-gauge steel.
 - 2. Element Supports: Adjustable.
 - a. Provide additional brackets where supply and/or return pipes are located in enclosure.
 - 3. Finish:
 - a. Primer: Zinc.
 - b. Top Coat: Enamel.
 - c. Color: Selected by Architect from manufacturer's standards.
 - 4. Gasket:
 - a. Location: Between back panel and wall.
 - b. Material: Sponge rubber.
 - 5. Accessories: Provide manufacturer's standard accessories of steel, same gauge as enclosure, as required, including, but not limited to:
 - a. Inside corners.
 - b. Outside corners.
 - c. End caps.
 - d. Access sections.
 - e. Extensions.
 - f. Knob operated dampers, where shown on drawing.

2.5 ELECTRIC PROPELLER UNIT HEATERS

- A. Manufacturers:
 - 1. Berko
 - 2. Indeeco
 - 3. Markel
 - 4. Modine
 - 5. QMark

6. Raywall
7. Trane

B. Construction:

1. Casing:
 - a. Material: Steel.
 - b. Finish: Baked-on enamel.
 - c. Heating Element Supports: Adjustable.
 - d. Gaskets: Between front panel and enclosure.
2. Louver: Adjustable.
3. Heating Element: Finned steel sheaths providing extended surface.
4. CSA listed, ETL listed, or UL listed
5. Provide manufacturer's written certification that unit is suitable for use at altitude of the project.

2.6 ELECTRIC PROPELLER CEILING HEATERS

A. Manufacturers:

1. Berko
2. Indeeco
3. Markel
4. QMark
5. Raywall

B. Construction:

1. Casing:
 - a. Material: Steel.
 - b. Finish: Powder coat.
2. Mounting: Surface mount or recessed mount as scheduled.
3. Heating Element: Finned steel sheaths.
4. CSA listed, ETL listed, or UL listed
5. Provide manufacturer's written certification that unit is suitable for use at altitude of the project.

2.7 ELECTRIC WALL HEATERS

A. Manufacturers:

1. Berko
2. Indeeco
3. Markel
4. QMark
5. Raywall

B. Construction:

1. Casing:
 - a. Material: Steel.
 - b. Finish: Powder coat.
2. Mounting: Surface mount or recessed mount as scheduled.
3. Heating Element: Finned steel sheaths.
4. CSA listed, ETL listed, or UL listed
5. Provide manufacturer's written certification that unit is suitable for use at altitude of the project.

PART 3 - EXECUTION

3.1 GENERAL

A. Locate units so clearance is provided for:

1. Service and maintenance.
2. Enclosure removal.

B. Level or pitch elements as required:

1. Install shims if necessary.

C. Touch-up finish after final adjustment.

D. Replace damaged enclosures.

E. Straighten bent fins.

F. Replace damaged elements.

END OF SECTION 23 82 39

SECTION 23 90 00 - PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. The contractor shall summarize and document adherence with the requirements of the specifications for project closeout including:
 - 1. Copies of all warranties
 - 2. Operation & Maintenance Manuals
 - 3. Required tests
 - 4. Test and balance reports
 - 5. Record drawings
 - 6. Permit requirements
 - 7. Valve tag list
- B. The contractor shall compile a closeout manual which shall include:
 - 1. A list of all required tests and a place for signoff of date completed.
 - 2. A list of all submittals with dates of acceptance by the engineer.
 - 3. A schedule indicating dates for beginning testing and startup of equipment and dates of tests to be witnessed by the engineer, or designated representative, as required by the specifications.
 - 4. Test procedures to be used for life safety systems.
 - 5. Project close out check list.
- C. The final closeout manual shall include the following:
 - 1. Test reports as required by the specifications with signoff by the appropriate individual (engineer, architect, building official, etc.).
 - 2. Documentation indicating all equipment is operating properly and is fully accessible for maintenance.
 - 3. Copies of all warranties.
 - 4. Test and Balance report.
- D. This section only includes the requirements for documentation of the contract documents, by the contractor, for project completion. This section does not in any way decrease the scope of any of the drawings or specifications.

1.2 SUBMITTALS

- A. Within 90 days after notice to proceed submit a preliminary closeout manual with the following:
 - 1. A list of all required tests.
 - 2. Preliminary schedule showing major milestones for completion of the mechanical/plumbing systems.
- B. Within 30 days of substantial completion submit the completed closeout manual as described in Part 1.
- C. Within 2 weeks of substantial completion submit a completed "Project Closeout Check List", and the Final Closeout Manual.
- D. Listed below is a checklist for use by the contractor. This list is not all inclusive for this project.

Project Close-Out Summary – Mechanical, Plumbing and Fire Protection

- ☐ All required submittals have been cleaned, submitted and either been approved or modified in accordance with the Engineer's "make corrections noted" comments. Our records indicate the following submittals are still outstanding:
- ☐ Clean filters installed in all units. (Install just prior to building turnover)
- ☐ Attic stock provided as required in the following sections:
 - ☐ 22 11 23 Pump Shaft Seals
 - ☐ 23 05 01 Auxiliary Starter Contacts
 - ☐ 23 05 30 VFD Fuses
 - ☐ 23 40 00 Spare Filters
- ☐ All equipment has been started up and is functioning within manufacturers' recommendations without any undue noise or vibration. (Submit a list of equipment with startup dates. Provide list no later than 120 days prior to project completion date).
- ☐ All vibration isolation has been installed and is operating properly.
- ☐ Duct access doors have been installed at fire and fire/smoke dampers and are properly fire-stopped and fire and fire/smoke dampers have been visually inspected to confirm that they are open.
- ☐ Access doors have been installed as required for concealed equipment, water hammer arrestors, valves, controls, actuators, etc.
- ☐ Chemical treatment system installed per specification and functioning properly.
- ☐ All equipment has been installed with the manufacturers recommended service clearances and is fully accessible for required maintenance.
- ☐ All equipment and piping are labeled per specifications.

- ☐ All hydronic, gas and plumbing piping cleaned, flushed and tested per specifications. Submit testing reports for record. Submit letter stating domestic water disinfection (chlorination) has been completed per the specifications.
- ☐ All action items are complete as listed in the action items reports. Submit a list of action items with sign off by Architect or Engineer for record. Punch list to be completed prior to turn over of building.
- ☐ Temperature control system complete and tested per specifications.
- ☐ Test and balance complete and report submitted and accepted by Engineer.
- ☐ Fire sprinkler system and pump tested per specifications.
- ☐ Operation and maintenance manuals submitted with table of contents and required documentation for extended warranties.
- ☐ Factory Testing documented and submitted for record.
- ☐ Record drawings submitted per specifications.
- ☐ Temperature Control record documents provided per specifications.

PART 2 - EXECUTION

2.1 EQUIPMENT STARTUP AND TESTING

- A. Prior to completion and punchlist by the engineer, the contractor shall startup and test each piece of equipment as required by the specifications. The contractor shall provide documentation of all required tests with signoff of by the appropriate individual (engineer, architect, and building official).

2.2 LIFE SAFETY SYSTEMS

- A. All life safety systems shall be fully and successfully tested by the contractor before being witnessed by the engineer or building official
- B. The contractor shall provide a detailed test procedure, with instrumentation to be used, for approval by the engineer and building official prior to any testing.
- C. Once tested by the contractor and fully operational, the systems shall be demonstrated to the engineer. Once accepted by the engineer the system shall be demonstrated to the building and fire officials.

2.3 COORDINATION WITH OTHERS

- A. The Division 21 through 23 contractor shall coordinate his requirements with the General Contractor to ensure the other building systems are completed to the point that they will not adversely affect the operation of the Division 21 through 23 systems.

2.4 PUNCH LISTS

- A. The contractor shall submit in writing that the project is ready for final review by the engineer.
- B. Once the project is ready for final review the engineer will create a punch list of any corrections or deficiencies.
- C. The contractor shall complete all punch list items and provide a letter to the architect after completion stating all items have been completed or reasons why they were not completed.
- D. Upon receipt of this letter the engineer will verify that the punch list has been satisfactorily completed.

END OF SECTION 23 90 00

SECTION 26 05 00 - ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. This Section supplements Division 1, General Requirements.
- B. Where contradictions occur between this Section and Division 1, the more stringent of the two shall apply. Architect shall decide which is most stringent.
- C. Provisions of Divisions 21, 22, 23, 27 and 28 shall also apply to the work of this section as if fully repeated here.
- D. Provision indicate Section 23 05 01/26 05 01 "Mechanical and Electrical Coordination" shall also apply to the work of this section as if fully repeated here.

1.2 REGULATORY REQUIREMENTS

- A. All materials shall conform to the current applicable industry standards. Workmanship and neat appearance shall be as important as electrical and mechanical operation. Defective or damaged materials shall be replaced or repaired prior to final acceptance in a manner meeting approval of the Architect and at no additional cost to the Owner.
- B. The latest editions of the following standards are minimum requirements.
 - 1. Underwriters' Laboratories, Inc. (UL)
 - 2. National Electrical Manufacturer's Assoc. (NEMA)
 - 3. American National Standards Institute (ANSI)
 - 4. Institute of Electrical and Electronic Engineers (IEEE)
 - 5. International Electrical Testing Association (NETA)
 - 6. Insulated Cable Engineer's Association (ICEA)
- C. All work and materials shall comply with latest rules, codes and regulations including, but not limited to the following:
 - 1. OSHA.
 - 2. National Fire Codes of National Fire Protection Assoc. (NFPA)
 - 3. National Electrical Safety Code (NESC, ANSI C2)
 - 4. National Electrical Code 2020 Edition with city, county and state Amendments.
 - 5. International Building Code 2018 Edition with city, county and state Amendments.
 - 6. 2010 ADAAG Americans with Disabilities Accessibility Guidelines.
 - 7. All applicable Federal, state and local laws, code amendments and regulations.

- D. Code compliance is mandatory. Nothing in these drawings and specifications permits work not conforming to these codes.
- E. No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, Contractor shall be responsible for all work required to open and restore the concealed area including all required modifications.
- F. Contradictions: Where Codes are contradictory, follow the most stringent. Architect/Engineer shall determine which is most stringent.

1.3 CONTRACT DOCUMENTS

- A. Drawings indicate general arrangement of circuits and locations of outlets, conduit, and other work. Information shown on drawings is as accurate as planning can determine, but not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is directed. Review all architectural, structural and mechanical drawings, and adjust all work to conform to all conditions shown therein. Architectural drawings shall take precedence over all other drawings. Discrepancies between different drawings or between drawings and specifications or regulations and codes governing installation shall be brought to attention of the Architect.
- B. Where the Drawings and Specifications do not comply with the minimum requirements of the Codes, either notify the Architect/Engineer in writing during the Bidding Period of the revisions required to meet Code requirements, or provide an installation which complies with the Code requirements. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.
- C. Follow Drawings and Specifications where they are superior to Code requirements. The more stringent of plans and drawing shall apply.

1.4 COORDINATION DRAWINGS

- A. Prepare coordination drawings in accordance with Division 1 "Submittals" to a scale of $1/4" = 1'-0"$ or larger; detailing major elements, components, and systems of electrical equipment (i.e., all transformer vaults, switchgear rooms, generator rooms, electrical rooms and technology rooms) and materials in relationship with other systems, installations, and building components. Where equipment is located outdoors, prepare shop drawings indicating electrical equipment locations and exterior elements in the equipment areas. Indicate locations where space is limited for installation and access and where sequencing and coordination of

installations are important to the efficient flow of the work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of major raceway systems, and materials. Include the following:
 - a. Exterior wall and foundation penetrations.
 - b. Fire-rated wall and floor penetrations.
 - c. Support details.
 - d. Sizes and location of required concrete pads and bases.
2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installation.
4. Underground conduit and duct bank routing.

1.5 RECORD DRAWINGS

- A. Refer to Division 1 for additional requirements.
- B. Maintain a blue-line set of Electrical Contract Drawings in clean, undamaged condition, for mark-up of installations which vary from the Contract Drawings. These drawings shall be a separate set of drawings, not used for construction purposes, and shall be kept up to date as the job progresses. This set shall be made available for inspection by the Engineer or Architect at all times. Upon completion of the contract a set of computerized "as built" capable of interfacing with AutoCAD software, shall be delivered to the Architect.
- C. Prepare record documents in accordance with the requirements in Division 1 Section "Project Closeout." In addition to the requirements specified in Division 1, indicate installed conditions for:
 1. Major raceway systems, size and location, for both exterior and interior and locations of handholes and conduit stub-up locations.
 2. Panelboard circuit directories reflecting all field changes.
 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 4. Results of all testing performed as specified in the specification.
 5. Certification of inspection from Authorities Having Jurisdiction.
- D. Record the locations and invert elevations of underground installations.

1.6 OPERATING AND MAINTENANCE MANUALS

- A. Refer to Division 1 for additional requirements.
- B. Submission:
 - 1. Submit an electronic copy of Operating and Maintenance Manuals prior to scheduling systems demonstration for the Owner.
- C. Requirement Contents:
 - 1. Manuals shall have either a combined file with bookmarks for each section or individual file for each section. If individual files, each digital file shall include section number and title in the file name.
 - 2. Submittal for each section shall identify all equipment and materials installed on the project.
 - 3. Manual to include contact information for a local supplier that can provide the specific piece of equipment.
 - 4. Provide certificates for such items of equipment which have warranties in excess of one year.
 - 5. Provide test results for each specification section identified herein.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- B. Protection of Equipment:
 - 1. All electrical equipment to be used in the construction shall be properly stored and protected against the elements. All equipment shall be stored under cover, and shall not be stored at the construction site on the ground, in mud, water, rain, sleet, or dust. Large diameter cables may be stored on reels outside; however, all cable ends shall be waterproofed and the reels covered with weatherproof materials. Such weatherproof materials shall be heavy-duty, securely fastened, and made impervious to the elements.
 - 2. Conventional electrical construction materials such as building wire, outlet and junction boxes, wiring devices, conduit, lighting fixtures, fittings, etc., shall be stored in construction buildings, covered trailers, or portable covered warehouses. Any equipment subject to damage or corrosion from excessive moisture shall be stored in dry, heated areas. Any equipment containing plastic or material subject to damage caused by excessive heat or sunlight shall be stored to prevent such damage. This includes plastic ducts and lenses.
 - 3. Equipment damaged as a result of the above conditions shall be properly repaired at the contractor's expense or shall be replaced at the contractor's expense, if in the opinion of the Engineer, the equipment has been damaged to such an extent that it cannot operate properly after repairs are made.

4. All electrical enclosures exposed to construction damaged such as paint spots, spackling or plaster spatter, grout splashes, waterproofing compound, tar spots or runs, and pipe covering compound splashes, shall be completely covered and protected against damage.
5. In the event leakage into the building of any foreign material or fluid occurs or may occur, the contractor shall take all steps as described above to protect any and all equipment.
6. After connections to electrical equipment are complete and the equipment is ready for operation, all construction debris shall be removed from all enclosures. Such debris includes dust, dirt, wire clippings, tape, and insulation removed in order to make the connection.

1.8 SAFETY AND INDEMNITY

- A. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. See also General Conditions.
- B. No act, service, drawings review or construction review by the Architect or Engineer, is intended to include review of the adequacy of the Contractor's safety measures in, on, or near the construction site.

1.9 WARRANTIES

- A. The warranty period is generally one year after Date of Acceptance.
 1. During this period, provide labor and materials as required to repair or replace defects in the electrical systems at no cost to the Owner. Provide certificate with O & M manual submittal which guarantees same day service response to the Owner's call for such warranty service.
 2. Provide certificates for such items of equipment which have warranties in excess of one year. Insert copies of O & M manual. Such equipment shall include:
 - a. Emergency lighting inverter
 - b. Transformers
 - c. Electrical panelboard
 - d. Lighting fixtures
 - e. Lighting Control
 - f. Fire alarm system
 3. Provide extended manufacturers warranties to cover one full year from Date of Acceptance if standard manufacturers' warranty ends any time prior to that date.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. All equipment and materials installed shall be new, unless otherwise specified.
- B. All major equipment components shall have manufacturers' name, address, model number and serial number permanently attached in a conspicuous location.
- C. All equipment shall be UL listed and bear the UL label.
- D. Specifications list approved products for the project, if not listed follow substitution request process.
- E. All areas directly exposed to outside air shall be considered exterior. Contractor's electrical installation, means and methods and materials used shall be appropriate for outdoor installations in these areas.

2.2 GENERAL SUBMITTAL REQUIREMENTS

- A. Coordination and Sequencing:
 - 1. After receipt of notice to proceed, the Contractor shall submit to the Architect a typed list of submittals and the scheduled date of submission. List shall include submittal number, section number and scheduled date of submission. Submittals shall be grouped and submitted in no more than ten complete packages.
 - 2. The contractor shall not submit any shop drawings or product data that does not comply with the contract documents. Prior to submitting shop drawings, review submittal for compliance with Contract Documents and place a stamp or other confirmation thereon which states that submittals have been reviewed. Submittals without such verification will be returned disapproved without review.
 - 3. Submittal is for information and record, unless otherwise indicated, and is not a change order request.
- B. Preparation of Submittals:
 - 1. Refer to Division 1 requirements.
 - 2. The Contractor shall submit for approval by the Architect data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Provide complete electrical characteristics for all equipment. Submit product submittals on items as outlined in sections hereinafter.
 - 3. Product submittals shall be made by specification section. All items of a section, requiring submission, shall be submitted together in one individual electronic file.

4. If two or more sections require inter-coordination (e.g., emergency generator and transfer switch; short circuit study, coordination study, electrical room layouts and electrical switchboards, fire alarm and fire command center layout), they shall be submitted at the same time. If electrical gear is submitted without electrical room layouts, short circuit study, coordination study, the submittal will be returned without review.
5. Each section shall be submitted as an individual file with section number and section name in the file name of the submittal.
6. Submittals of an entire product catalog will be rejected without review. Products to be used on the project must be indicated on cut sheets.
7. Provide cover letter in electronic file identifying project name, Contractor, Subcontractor, submittal name, date of submission, specification section, and information to distinguish it from other submittals.
8. Submittals not presented in individual electronic files or neat and legible fashion will be returned "Without Action."
9. Submittals shall show Contractor's executed review and approval marking. Submittals which are received from sources other than through Contractor's office will be returned "Without Action."
10. Provide space for Architect's "Action" marking.

C. Substitutions

1. Refer to the General Conditions, which govern "Substitution" of specified equipment or materials.
2. Indicate any portions of work which deviate from the Contract Documents.
 - a. Explain the reasons for the deviations.
 - b. Show how such deviations coordinate with interfacing portions of other work.
3. Where substitution of materials alters space requirements indicated on the drawings, submit shop drawings indicating proposed layout of space, all equipment to be installed therein and clearances between equipment (i.e., electrical rooms). All clearances required by the National Electrical Code and applicable state and local regulations must be maintained.

D. Review Process

1. The Architect reserves the right to require a sample of any equipment to be submitted for approval and to retain its possession.
2. Refer to the individual sections for identified equipment and material for which submittals are required. In addition, provide shop drawings and product data on the following equipment:

Electrical Power Conductors and Cables
Grounding and Bonding
Hangers and Supports
Raceway and Boxes
Underground Duct, Raceway & Manholes

Identification
Network Lighting Control
Low-Voltage Distribution Transformers
Switchboards
Panelboards
Wiring Devices
Fuses
Surge Protection Device
Lighting Fixtures
Poles and Standards

Do not submit on equipment or materials not requested in the specifications.

3. Review of shop drawings and product data by the Architect/Engineer, including any review annotations or stamp notations, does not relieve the contractor from the required compliance with the contract documents.
4. The shop drawing and product data review stamp notation requirements are defined as follows:
 - a. "NO EXCEPTION TAKEN:" The reviewer did not observe any items which were not in compliance with the contract documents. All dimensions, details, and coordination with other trades are the responsibility of the contractor.
 - b. "MAKE CORRECTIONS NOTED:" The reviewer indicated items observed that were not in compliance with the contract documents. The contractor shall not resubmit, but shall make corrections and provide corrected documents with the "Record Drawings."
 - c. "REJECTED, REVISE AND RESUBMIT:" The reviewer indicated items observed which were not in compliance with the contract documents. The contractor shall resubmit showing corrections of all noted items. Delays for resubmittal do not relieve the contractor from meeting project schedules.
 - d. "REJECTED:" The submission does not comply with the contract requirements. The entire submittal must be corrected and submitted for review. Delays for resubmittal do not relieve the contractor from meeting project schedules.
5. If shop drawings are submitted and returned as "NO EXCEPTION TAKEN" or "MAKE CORRECTIONS NOTED" and meet contract requirements, the contractor shall not resubmit any other shop drawings for these items.
6. If resubmittals are necessary, they shall be made as specified above for submittals. Resubmittals shall highlight all revisions made and cover shall include the phrase "RESUBMITTAL NO. _____."
7. Resubmittal requirements do not entitle the Contractor to additional time and are not a cause for delay of the project.

PART 3 - EXECUTION

3.1 CONDITIONS AT SITE

- A. Visit to site is required of all bidders prior to submission of bid. All bidders will be held to have familiarized themselves with all discernible conditions, and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.
- B. Lines of other services and/or equipment that are damaged as a result of this work shall promptly be repaired at no expense to the Owner.

3.2 LICENSES, FEES AND PERMITS

- A. Arrange for required inspections and pay all license, permit and inspection fees. Furnish a certificate of final inspections and approvals from local authority having jurisdiction over electrical installation.

3.3 WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS

- A. Only professional quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.
- B. Provide foreman in charge of this work at all times. Foremen for this work shall have had experience in installing not less than 5 such electrical systems of equal or greater complexity.
- C. Where specifications call for an installation to be made in accordance with manufacturers' recommendations, a copy of such recommendations shall at all times be kept in job superintendent's office.

3.4 RELATION WITH OTHER TRADES

- A. Contractor shall coordinate work of this Division with other trades to avoid conflict and to provide rough-ins and other connections for equipment furnished under other divisions that require electrical connections. Inform other trades of required clearances of accesses for or around electrical equipment to maintain serviceability and code compliance.
- B. Verify equipment dimensions and rough-in requirements for Divisions 2 through 28 with provisions specified under this Section of work, and report discrepancies to the Architect in ample time to prevent delays or unwarranted changes of work.

3.5 TESTING

- A. Provide all labor, materials, and equipment necessary to make required tests. Tests shall be complete and results approved before final inspection is begun.

3.6 PROGRESS OF WORK

- A. Order progress of electrical work so as to conform to progress of work of other trades, and complete entire installation as soon as condition of building will permit. Assume any cost resulting from defective or ill-timed work performed under this Division.

3.7 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 1 Section "Cutting and Patching." In addition to the requirement specified in Division 1, the following requirements apply:
 - 1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Uncover work to provide for installation of ill-timed work.
 - b. Remove and replace defective work.
 - c. Remove and replace work not conforming to requirements of the Contract documents.
 - d. Remove samples of installed work as specified for testing.
 - e. Install equipment and materials in newly installed structures.
 - f. Upon written instructions from the architect, uncover and restore work to provide for Architect observation of concealed work.

3.8 SLEEVES

- A. Place sleeve in forms of walls, floor slabs and partitions for passage of all conduits, pipes, and ducts installed under Divisions 26, 27 and 28. Sleeves shall be set in place a sufficient time ahead of concrete work so as not to delay that work. Install sleeves and raceways through exterior walls so as to provide a waterproof installation. All floor penetrations shall be made watertight. Conduits passing through walls shall be installed to preserve integrity of the wall rating (i.e., fire rating, sound rating, air, etc.). All penetration made through existing concrete slabs or walls shall be x-rayed and approved by Structural Engineer prior to cutting.

3.9 EXCAVATION, TRENCHING, AND BACKFILLING

- A. Perform all excavation to install conduit and duct banks indicated on the drawings or specified herein. During excavation, pile material for backfilling back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. Remove and dispose of all excavated

materials not to be used for backfill. Grade to prevent surface water from flowing into trenches and excavation. Remove any water accumulating therein by pumping. Do all excavation by open cut. No tunneling shall be done unless indicated on the drawings or unless written permission is received from the Architect.

- B. Grade the bottom of trenches to provide uniform bearing and support for conduits or duct bank on undisturbed soil at every point along its entire length. Tamp over depths with loose, granular, moist earth. Remove unstable soil that is not capable of supporting equipment or installation and replace with specified material for a minimum of 12" below invert of equipment or installation.
- C. Backfill the trenches with excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel or soft shale. These materials should be free from large clods of earth and stones, deposited in 6" layers and rammed until the installation has cover of not less than the adjacent ground but not greater than 2" above existing ground. Backfilling shall be carried on simultaneously on both sides of the trench so that injurious pressures do not occur. Compaction of the filled trench shall be at least equal to that of the surrounding undisturbed material. Do not settle backfill with water. Reopen any trenches not meeting compaction requirements or where settlement occurs, refill, compact, and restore surface to grade and compaction indicated on the drawings, mounded over and smoothed off.
- D. In addition, all excavation and backfilling shall comply with Division 2. The most stringent requirement shall apply.

3.10 CLEANUP

- A. Remove all materials, scrap, etc., relative to electrical installations and leave premises in a clean, orderly condition. Any costs to the Owner for cleanup of site will be charged to the Contractor. At completion, all equipment, raceways, etc., shall be thoroughly cleaned and all residue removed from the inside and outside surfaces. Defaced finish shall be refinished.

3.11 TEMPORARY POWER

- A. Provide temporary power as requested by the general contractor and in accordance with OSHA and local code requirements. Lighting and power outlets shall be provided throughout the project. Check with construction manager or general contractor prior to bid for special lighting and power outlets and provide as needed.

3.12 MINOR CHANGES

- A. The Owner reserves the right to make minor changes in the locations of outlets and equipment up to the time of electrical rough-in without any cost to the Owner.

3.13 ELEVATOR COORDINATION

- A. Provide control wiring as required by elevator vendor.
 - 1. 2# 12-1" C from auxiliary contact (closed before switch returns to normal power) on transfer switch serving elevators to each elevator machine room which is served via that transfer switch. Terminate as and where required by the elevator vendor.
- B. Provide 1" conduit from elevator controller to fire alarm control panel for elevator communication system, as required by elevator vendor.

3.14 ELECTRICAL SYSTEMS OPERATIONAL TESTS, CERTIFICATION, AND DESIGN AUTHORITY ASSISTANCE

- A. Testing
 - 1. Refer to the individual specification sections for test requirements.
 - 2. Prior to the final inspection, the systems or equipment shall be tested and reported as herein specified. One electronic copy of the tests shall be submitted to the Architect/Engineer for approval.
 - 3. All electrical systems shall be tested for compliance with the specifications.
- B. Manufacturers' Certifications
 - 1. The electrical systems specified herein shall be reviewed for compliance with these specifications, installation in accordance with the manufacturers' recommendations and system operation by a representative of the manufacturer. The manufacturer shall submit certification that the system has been installed in accordance with the manufacturers' recommendations and is operating as specified in the contract documents.
- C. Design Authority Assistance
 - 1. The Contractor shall provide personnel to assist the Architect/Engineer or their representative during all construction review visits. The Contractor shall provide all necessary tools and equipment to demonstrate the system operation and provide access to equipment, including screwdrivers, wrenches, ladders, flashlights, circuit testing devices, meters, keys, etc.
 - 2. Remove equipment covers (i.e., switchgears, switchboards, panelboard trims, panelboards, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring. Accessible ceiling shall be removed as directed for inspection of equipment installed above ceilings. Reinstall all covers or ceilings after inspection.
 - 3. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment as directed by Architect/Engineer.
 - 4. The Contractor shall provide authorized representatives of the manufacturers to demonstrate to the Architect/Engineer compliance with the specifications of their

respective system during or prior to the final inspection at a time designated by the Architect. Refer to the appropriate specification section for additional testing requirements. Representatives of the emergency generator/automatic transfer switch and fire alarm systems are required for demonstrations.

3.15 COMMISSIONING

- A. After startup and testing of each system has been completed, the Owner shall have an independent firm conduct detailed observations of the equipment and systems to confirm compliance with the Contract Documents.
- B. The Division 26 Contractor shall include, as part of the work of his contract, costs to cover manpower, equipment, tools, ladders, instruments, etc., necessary to expedite the system performance observations.
- C. The independent firm shall develop systems, equipment checkout procedures and data forms for recording compliance of the systems to the Contract Documents, performance, and construction observation lists, and will assist in developing schedules for checkout and Owner acceptance, at a future date during the construction phase.

END OF SECTION 26 05 00

SECTION 23 05 01/26 05 01 - MECHANICAL AND ELECTRICAL COORDINATION

PART 1 - GENERAL

1.1 RESPONSIBILITY

- A. The Divisions 21 through and 26 through 28 contractor(s) shall comply with the provisions of this section. The Divisions 21 through 23 contractor(s) shall verify electrical service provided by the electrical contractor before ordering any mechanical equipment requiring electrical connections. Provide submittals of all mechanical equipment to Division 26 through 28 contractor(s).
- B. The final responsibility for properly coordinating the electrical work of this section shall belong to the Divisions 21 through 23 system contractor performing the work, which requires the electrical power.
 - 1. Each Divisions 21 through 23 contractor shall be responsible for providing power wiring for certain devices as described in the specifications and on the drawings. This work shall be provided by a licensed electrician in accordance with all of the applicable provisions of the Division 26 through 28 specifications, NEC and local codes.

1.2 WORK INCLUDED

- A. Carefully coordinate the interface between Divisions 21 through 23 (Mechanical) and Divisions 26 through 28 (Electrical), and Division 23 09 00 (Building Management and Automatic Temperature Control Systems) before submitting any equipment for review or commencing installation

1.3 DEFINITIONS

- A. Automatic: Pertaining to a function, operation, process or device that, under specified conditions, functions without intervention by human operator.
- B. Disconnect Switch: A mechanical switching device used for changing the connections in a circuit, or for isolating a circuit or equipment from a power source.
- C. Motor Control Center: A floor-mounted assembly of one or more enclosed vertical sections having a common horizontal power bus and primarily containing motor starting units.
- D. Control Circuit/Power: The circuit which carries the electrical signals of a control apparatus or system directing the performance of the controller but does not carry the main power circuit.
- E. Manual Operation: Operation by hand without the use of any other power.

- F. MC: Mechanical Contractor = Divisions 21 through 23 Contractor who furnishes motor.
- G. TC: Temperature Controls = Division 23 09 00 Contractor who furnishes control.
- H. EC: Electrical Contractor = Divisions 26 through 28 Contractor.
- I. FA: Fire Alarm Contractor = Division 28 Contractor who furnishes Fire Alarm System.
- J. IPC: Ice Plant Contractor = Contractor who furnishes the Ice Plant System.
- K. EP: Electric to Pneumatic Converter.
- L. PE: Pneumatic to Electric Converter.

1.4 RESPONSIBILITY SCHEDULE

- A. Responsibility: Unless otherwise indicated, all motors and controls for Divisions 21 through 23 equipment shall be furnished, set in place and wired in accordance with the following schedule:

ITEM -	Furnished Under	Set In Place Under	Power Wiring Under	Control Wiring Under
MC: Mechanical Contractor TC: Temperature Contractor EC: Electrical Contractor FA: Fire Alarm Contractor				
AHU Interior Marine Lights	MC	MC	EC	MC
Equipment Motors	MC	MC	EC	--
Automatically or Manually Controlled Starters/Contactors: (Note 4)				
-Separate	MC	EC	EC	TC
-Factory Mounted and Wired	MC	MC	EC	TC
In Motor Control Centers (Note 4)	EC	EC	EC	TC
Motor Speed Controllers: (Note 4)				
-Separate	MC	EC	EC	TC
-Factory Mounted and Wired	MC	MC	EC	TC
Disconnect Switches (Note 1)	EC	EC	EC	--
Thermal Overload Switches (Note 1)	EC	EC	EC	--
Switches (Manual or Automatic other than disconnect) (Note 2)	MC or TC	MC or TC	EC or TC	TC or MC
Control Relays (Note 2)	MC or TC	MC or TC	--	TC
Control Transformers	MC or TC	MC or TC	EC or TC	TC
Push Button Stations, Pilot Lights	MC	EC	EC	EC
Thermostat and Controls: Integral with Equipment or Directly Attached to Ducts, Pipes, etc. (Note 2)	MC or TC	EC or TC	EC or TC	TC
Equipment in Temperature Control Panels	TC	TC	TC	TC

ITEM -	Furnished Under	Set In Place Under	Power Wiring Under	Control Wiring Under
MC: Mechanical Contractor TC: Temperature Contractor EC: Electrical Contractor FA: Fire Alarm Contractor				
Standalone Control Panels (BAS) (Note 6)	TC	TC	TC	TC
Valve Motors, Damper Motors, Solenoid Valves, etc.	TC	TC	TC	TC
EP Valves or Switches, P.E. Switches, etc.	TC	TC	--	TC
Fire Alarm System (Note 3)	FA	FA	EC	FA
Fire Sprinkler Alarm (Note 3)	MC	MC	EC	FA
Duct System Smoke Detectors (Note 5)	FA	MC	--	TC/FA
Relays for Fan Control via duct detectors (Note 5)	MC	MC	EC	TC
Room Smoke Detectors Including Relays for Fan Control (Note 3)	FA	FA	--	FA
Smoke Management Controls (Note 7)	FA	FA	EC	FA
CO Sensors	TC	TC	TC	TC
Control Air Compressor	TC	TC	TC	TC
Refrigerated Air Dryer	TC	TC	TC	TC
Equipment Interlocks	TC	TC	--	TC
Fire/Smoke and Smoke Dampers (Note 7)	MC	MC	EC	FA
Smoke Control Dampers (for smoke management system)	MC	MC	EC	FA/TC
Positive Indication Devices (i.e., current sensors, end switches, airflow sensors)	TC	TC	--	FA/TC
Heat Trace Systems (Note 8)	MC	MC	MC	MC
Ice Plant Equipment (other than outdoor condensing unit)	IPC	IPC	IPC	IPC
Ice Plant Outdoor condensing unit.	IPC	IPC	EC	IPC
Ice plant Motor Control Center (Note 9)	IPC	IPC	IPC	IPC

Notes:

1. If furnished as part of factory wired equipment furnished and set-in place by MC, wiring and connections by EC.
2. If float switches, line thermostats, P.E. switches, time switches, or other controls carry the FULL LOAD CURRENT to any motor, they shall be furnished by MC, but they shall be set in place and connected by EC, except that where such items are an integral part of the mechanical equipment, or directly attached to ducts, piping, or other mechanical equipment, they shall be furnished and set-in place by MC and connected by EC. If they

do not carry the FULL LOAD CURRENT to any motor, they shall be furnished, set in place and wired by TC contractor.

3. Pre-action system initiation signals (such as smoke detectors or general alarm conditions in a pre-action zone) shall be provided under Division 28.
4. Electrical contractor is responsible for wiring from starter to motor, unless factory wired.
5. Temperature control contractor shall provide conduit and wire from auxiliary contact in motor starter to the detector so that the unit shuts down in all operating modes. Fire Alarm Contractor to wire from detector to fire alarm panel.
6. Each division shall be fully responsible for any control panels as called for on the drawings or specifications.
 - a. Division 26 shall provide all power and control wiring to fire/smoke or smoke dampers. Division 23 and 26/28 shall provide parallel control wiring (with 28 fire alarm having priority signal) to dampers and equipment utilized in both normal and smoke control modes. Refer to Smoke Control and Fire Alarm Drawings and the Fire Alarm Matrix.
 - b. Fire alarm system shall override automated building control system during smoke exhaust mode.
 - c. TC wiring to fire/smoke or smoke dampers required only when damper also serves HVAC system.
7. Mechanical contractor shall be responsible for fully functional heat trace system. Mechanical contractor shall engage licensed electrician to install heat trace system. Where applicable, mechanical contractor shall engage temperature controls contractor to install control wiring to Division 23 09 00 system.
8. Electrical contractor shall bring power to a fused disconnect adjacent to the motor control center. This disconnect shall be the line of delineation for the Ice Plant Contractor and the Electrical Contractor. The electrical contractor shall make the terminations to this disconnect on the line side of this equipment. The ice plant contractor shall make the terminations on the load side of the equipment and finish the electrical installation of the motor control center from this termination.

- B. Power Wiring by Divisions 21 through 23: The electrical power for certain equipment provided under Divisions 21 through 23 has not been specifically indicated on the electrical drawings and must be provided by and field coordinated by the Divisions 21 through 23 trade requiring such power.

Sufficient power for this purpose shall be furnished as "spare" dedicated circuit capacity in Division 26's panelboards. All wiring, conduit and electrical devices downstream of the panelboards are the responsibility of the Divisions 21 through 23 trade requiring the power.

1. Such equipment is hereby defined as:
 - a. Electrical heat trace. Required heat trace locations, capacities and specification are shown on the plumbing and mechanical drawings (Division 22 and 23 work).

- b. Fire protection air compressors, dry-pipe control panels and valves. Required connections are included in the Division 21 work and will be shown by that contractor's engineered system design drawings.
 - 1) Pre-action system initiation signals (such as smoke detectors or general alarm conditions in a pre-action zone) shall be provided under Division 28 fire alarm work.
 - 2) Division 21 shall provide pre-action control panel and interconnection between nearest suitable fire alarm panel and location of pre-action valve(s).
 - 3) Division 28 shall provide interconnection between fire command center alarm panel (provided under Division 28) and remote communication fire alarm panel (provided under Division 28).
- c. Infrared plumbing fixtures. Fixtures requiring power are shown on the plumbing drawings and schedules. Provide junction box and or receptacle as required by manufacturer.
- d. Temperature control panels, control air compressors and line voltage power for 24v control transformers. Required connections are included in Division 23 09 00 and will be shown by that contractor's control submittal drawings.
- e. Condensate pumps. Provide power from associated unit or from nearby panelboard.

1.5 GENERAL REQUIREMENTS

A. Connections:

- 1. Connections to all controls directly attached to ducts, piping and mechanical equipment shall be made with flexible connections.

B. Starters:

- 1. Provide magnetic starters for all three phase motors and equipment complete with:
 - a. Control transformers.
 - b. 120V holding coils.
 - c. Integral hand-off-auto switch.
 - d. Auxiliary contacts required for system operation plus one (1) spare.
 - e. Refer to Section 23 05 13 Motors, Starters and Drives.

C. Remote Switches and Pushbutton Stations:

- 1. Provide remote switches and/or pushbutton stations required for manually operated equipment (if no automatic controls have been provided) complete with pilot lights of an approved type lighted by current from load side of starter.

D. Special Requirements:

1. Motors, starters and other electrical equipment installed in moist areas or areas of special conditions, such as explosion proof, shall be designed and approved for installation in such areas with appropriate enclosure.

E. Identification:

1. Provide identification of purpose for each switch and/or pushbutton station furnished. Identification may be either engraved plastic sign permanently mounted to wall below switch or stamping on switch cover proper. All such identification signs and/or switch covers in finished areas shall match other hardware in the immediate area.

F. Control Voltage:

1. Maximum allowable control voltage 120V. Fully protect control circuit conductors in accordance with National Electrical Code.

G. DDC Control Interface:

1. Fully coordinate the requirements of each division with regard to supplying a complete DDC Control System prior to submitting bid.
2. All control power shall be furnished via dedicated line voltage circuits.
3. Dedicated control circuits from electrical panelboards to DDC control panels and from electrical panelboards to dedicated DDC J-boxes (for distributed control components such as VAV boxes), and control transformer line voltage connections shall be provided under Division 23 09 00 where required and as shown on the drawings.
 - a. Exceptions: The following Divisions 21 through 23 equipment has been provided with electrical power feeders downstream of the panelboards by Division 26:
 - 1) Division 28, Fire Alarm System Panels.
 - 2) Division 23 09 00 Building Automation System (BAS):
 - a) Each air handling unit (AHU) has been provided with a dedicated combination control and unit lighting circuit(s) to its air handling room.
 - b) Certain BAS panels requiring emergency power.
 - 3) See the drawings for additional exceptions.
4. Low-voltage wiring from J-boxes to distributed control components, all low-voltage connections, all control panels and all control transformers (not part of unitary equipment) shall be provided under Division 23 09 00.
5. Any additional power requirements shall be the responsibility of the Division 23 09 00 Contractor requiring same and provided at no additional cost to the owner.

1.6 CEILING AND CHASE CAVITY PRECEDENCE

- A. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order of precedence. A system with higher precedence may direct that systems of lower precedence be relocated from space, which is required for expedient routing of the precedent system.
1. Plumbing waste, cooling coil drain piping, and roof drain mains and leaders.
 2. Hydronic main piping (12" and larger).
 3. Plumbing vent piping.
 4. Supply, return and exhaust ductwork.
 5. Electrical conduit greater than 4" diameter.
 6. Hydronic branch and mains (greater than 2", but less than 12").
 7. Domestic water piping.
 8. Fire sprinkler mains and leaders.
 9. Hydronic branch piping (2" and less).
 10. Domestic hot and cold-water branches.
 11. Electrical conduit branch feeders.
 12. Fire sprinkler branch piping and sprinkler runouts.
- B. Light fixtures have precedence in a zone, which is the same height above the ceiling as the depth of the fixture (plus 2").
- C. Examine the contract documents of all trades (e.g., all Divisions 21 through 23 and 26 through 28 drawings, the architectural floor plans, reflected ceiling plans, elevations and sections, structural plans and sections, etc.).
- D. Coordinate necessary equipment, ductwork and piping locations so that the final installation is compatible with the materials and equipment of the other trades.
- E. Prepare shop drawings for installation of all new work before installation to verify coordination of work between trades.
- F. Provide access doors for all equipment, valves, clean-outs, actuators and controls which require access for adjustment or servicing and which are located in otherwise inaccessible locations.
1. For equipment located in "accessible locations" such as lay-in ceilings: Locate equipment to provide adequate service clearance for normal maintenance without removing architectural, mechanical, electrical or structural elements such as the ceiling support system, electrical fixtures, etc. "Normal maintenance" includes, but is not limited to: filter changing; greasing of bearings; using p/t ports for pressure or temperature measurements; and replacement of ballasts, fuses, etc.

PART 2 - PRODUCTS

2.1 MOTOR HORSEPOWER

- A. In general, all motors $\frac{3}{4}$ HP and above shall be three phase, all motors $\frac{1}{2}$ HP or less shall be single phase.
- B. Voltage and phase of motors as scheduled on the electrical drawings shall take precedence in the case of a conflict between the mechanical and electrical drawings or general condition 2.1. A., above.
- C. Work under Divisions 21 through 23 includes coordinating the electrical requirements of all mechanical equipment with the requirements of the work under Divisions 26 through 28, before ordering the equipment.
 - 1. If motor horsepower are changed under the work of Divisions 21 through 23 without a change in duty of the motor's driven device, coordination of additional electrical work (if any) and additional payment for that work (if any) shall be provided under the section of Divisions 21 through 23 initiating the change. Increases or decreases in motor horsepower from that specified shall not be made without written approval from the Architect/Engineer.

PART 3 - EXECUTION - (NOT USED)

END OF SECTION 23 05 01/26 05 01

SECTION 26 05 02 - BASIC MATERIAL AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. This Section supplements Division 1, General Requirements.

1.2 DESCRIPTION OF WORK

- A. Work included in this section consists of conduits, wires and other miscellaneous materials not specifically mentioned in other sections of Division 26, 27 and 28 but necessary or required for equipment or system operation or function, and the labor to install them.

1.3 SUBMITTALS

- A. Materials list with manufacturer, style, series or model identified.
- B. Manufacturer's descriptive literature and/or sample if requested by the Architect/Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Refer to Section 26 05 03.

2.2 CONDUIT RACEWAYS

- A. Refer to Section 26 05 33.

2.3 ELECTRICAL POWER CONDUCTORS AND CABLES

- A. Refer to Section 26 05 19.

2.4 WIRING DEVICES

- A. Refer to Section 26 27 26.

2.5 OUTLET BOXES, JUNCTION AND PULL BOXES

- A. Outlet Boxes: Hot-dipped galvanized or sherardized of required size, 4" square minimum, for flush-mounted devices and lighting fixtures. Cast-type FD with gasketed covers for surface-mounted devices.
- B. Junction and Pull Boxes: Use outlet boxes as junction boxes wherever possible. Larger junction and pull boxes shall be fabricated from code-gauge sheet steel, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless-steel nuts, bolts, screws, and washers. Pull and junction boxes installed in finished spaces must be flush-mounted cabinets provided with trim, hinged door and flush latch and lock to match flush-mounted panelboard trim. Provide galvanized code-gauge steel where required for outdoor exposure.
- C. All exterior boxes shall be in use gasketed, weatherproof type with cast metallic covers.
- D. Refer to Section 26 05 33 for additional requirements.

2.6 WIRE CONNECTORS

- A. For wires that are #8 AWG and smaller: Insulated pressure type with live spring, rated 105°C, 600-Volt, for building wiring and 1000-Volt in signs or fixtures.
- B. For wires that are #6 AWG and larger: Compression type with 3M #33 or equal tape insulation.

2.7 CONDUIT HANGERS

- A. Refer to Section 26 05 29 for additional requirements.

2.8 FUSES

- A. Refer to Section 26 28 16.

2.9 ACCESS PANELS

- A. Electrical Contractor to provide access panels for electrical equipment which are required for accessibility by code.

2.10 CONDUIT SLEEVES

- A. Sleeves for Conduit Penetration: Hilti, Inc., model CP 6820-P; or 3M Corp. MCID or PCID. Refer to Division 7 "Firestopping" for additional requirements.

- B. Exterior Wall Penetration Seals: Provide seals at all foundation of exterior wall locations. Link Seal or approved manufacturer.

2.11 CONDUIT SLEEVES

- A. Sleeves for Conduit Penetration: Hilti, Inc., model CP 6820-P; or 3M Corp. MCID or PCID. Refer to Division 7 “Firestopping” for additional requirements.
- B. Exterior Wall Penetration Seals: Provide seals at all foundation of exterior wall locations. Link Seal or approved manufacturer.
1. New Construction – Cast in place shall be Century Line (HDPE) or Steel Wall Sleeve
 2. Existing Construction – Core Drilled

- C. Seal Product:

	Seal Element	Intended Application
C	EPDM (Black)	Direct ground burial, occasional or periodic water contact.
L	EPDM (Blue)	Use with fragile pipe and tubing. Direct ground burial, occasional or periodic water contact.
O	Nitrile	Oil, fuel and solvent resistant.
T	Silicone	Extreme temperatures rated (-55°C - +204°C).
S-316	EPDM (Black)	Chemical processing & wastewater treatment. High level of water resistance, inorganic acids and alkalis, and most organic chemicals.
LS-316	EPDM (Blue)	Use with fragile pipe and tubing. Chemical processing & wastewater treatment. High level of water resistance, inorganic acids and alkalis, and most organic chemicals.
OS-316	Nitrile	Oil resistant rubber with stainless steel hardware.

2.12 INTERNAL CONDUIT SEALANT

- A. Conduit sealant shall be used in all conduits penetrating the building envelope or moisture barrier to prevent rodents and moisture. Sealant shall be able to be removed without damaging the conductors.
1. Conduits 2” or greater – Polywater FST or approved equal.
 2. Conduits <2” – Poly Water FST Mini or approved equal.

2.13 EQUIPMENT MOUNTING AND SUPPORT HARDWARE

- A. Steel channels, bolts and washers, used for mounting or support of electrical equipment shall be galvanized typed. Where installed in corrosive atmosphere, stainless-steel type hardware shall be used.
- B. Refer to Section 26 05 29 for additional requirements.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide complete raceway systems for all conductors including control wiring and low-voltage wiring unless otherwise noted.
- B. Electrical system layouts indicated on drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from architectural drawings.
- C. All home runs to panelboards are indicated as starting from the outlet nearest to the panel and continuing in the general direction of that panel. Continue such circuits to panel as though routes were completely indicated.
- D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of the Architect, and conform to all structural requirements when cutting or boring structure.
- E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc., required for equipment specified under this Section.

3.2 RACEWAYS

- A. Refer to Section 26 05 33.

3.3 OUTLETS

- A. Exact location of outlets and equipment shall be governed by structural conditions and obstructions or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment. Verify final location of all outlets, panels, equipment, etc., with the Architect/Engineer.

- B. Provide zinc-coated or cadmium-plated sheet steel outlet boxes not less than 4" octagonal or square, unless otherwise noted. Equip fixture outlet boxes with 3/8" no-bolt fixture studs. Where fixtures are mounted on or in an accessible type ceiling, provide a junction box and extend flexible conduit to each fixture. Outlet boxes in finished ceilings or walls shall be fitted with appropriate covers, set to come flush with the finished surface. Where more than one switch or device is located on one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide tile box or a 4" square box with tile ring in masonry walls which will not be plastered or furred, or where "dry-wall" type materials are applied. Through the wall type boxes are not permitted. Install minimum 12" lateral separation for back to back boxes.
- C. Surface-mounted devices are to be mounted in cast type boxes with gasketed covers: (Crouse-Hinds FS/FD or equal).
- D. Dimensions unless shown on drawings are given below and are from finished floor to center line of outlets unless noted otherwise. Adjust heights of outlets in masonry walls to correspond with consistent brick or block course. Outlets in block walls shall be installed in core of block.

Wall Switches	4' - 0" (to top of box)
Convenience outlets	1' - 4" (to bottom of box) – gyp or 8" block 1' - 6" (to bottom of box) – 6" block
Hallways	1' - 6" (to bottom of box)
Above counter wall outlet	0' - 8" (above counter to top of box, maximum 44" AFF, field verify height of backsplash)
Panelboards wall mounted	6' - 6" (to top of back box)
Wall phone outlet	4' - 0" (to top of box)
Tele/Data outlets	1' - 6" (to bottom of outlet)
Fire alarm horns, speakers	ceiling or wall
Fire alarm pull stations	4' - 0" (to top of device)
Fire alarm strobes	6' - 8" or 6" below ceiling (whichever is lower)
Television outlets	Refer to A/V or architectural drawing.

Confirm final location and heights of all outlets, wall switches, and television outlets with architectural drawings and furniture plans prior to installation.

- E. Outlets except over counters, benches, special equipment, baseboards, fin tube radiators, etc., or at wainscoting, shall be at a height to prevent interference to service equipment, or as noted on drawings.
- F. Refer to Section 26 05 33 for additional requirements.

3.4 JUNCTION PULL BOXES

- A. Construct junction or pull boxes not over 150 cubic inches in size shall be standard outlet boxes, and those over 150 cubic inches shall be constructed the same as “Cabinets,” with screw covers of same gauge metal. Removal covers must be accessible at all times.
- B. Provide a standard access panel having a hinged metal door neatly fitted into a flush metal trim, where a junction box or equipment is located above non-accessible ceilings or behind finished walls. Coordinate location and type with the Architect.

END OF SECTION 26 05 02

SECTION 26 05 03 - MANUFACTURERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The following lists of manufacturers are for the specifications as identified.
- B. All submittals and documentation shall be in accordance with the project General Requirements, Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work are listed herein. All manufacturers not listed shall be pre-approved prior to bid in order to be considered. Refer to Division 1 for pre-approval format.

TITLE	SPECIFICATION SECTION	MANUFACTURER
Electrical Power Conductors and Cables	26 05 19	Aetna Insulated Wire Cerro Wire CME Wire and Cable Encore Wire Southwire Co.
Grounding and Bonding	26 05 26	ABB (Blackburn/Color-Keyed) nVent (Erico/Cadweld) Ideal Industries Hubbell (Burndy) VFC/Lyncole
Hangers and Supports		
- Slotted Metal Angle and U-channel Systems	26 05 29	ABB (Thomas and Betts Corp) Eaton (B-Line Systems) Atkore (Unistrut Diversified Products)
- Conduit Sealing Bushings	26 05 29	ABB (Thomas and Betts Corp.) Emerson (OZ/Gedney) Hubbell (RACO)

TITLE	SPECIFICATION SECTION	MANUFACTURER
Raceways		
- Conduit and Tubing	26 05 33	ABB (T&B - OCAL) Atkore (Allied Tube & Conduit) Carlson, Inc. JM Eagle Rob Roy Industries Wheatland
- Conduit Bodies	26 05 33	ABB (Thomas and Betts Corp.) Emerson (Appleton Electric) Eaton (Crouse-Hinds) Hubbell (Killark Electric)
Wireway and Enclosures	26 05 33	Eaton (Cooper B-Line) nVent (Hoffman) Hammond Mfg.
Surface Raceways	26 05 33	Hubbell Legrand (Wiremold)
Electrical Boxes and Fittings		
Raintight outlet boxes	26 05 33	ABB (T&B – Red Dot) Emerson (Appleton Electric) Eaton (Crouse – Hinds) Hubbell (RACO)
Bushings, knockout closures and locknuts	26 05 33	ABB (T&B – Steel City) Emerson (Appleton Electric) Eaton (Crouse – Hinds) Hubbell (RACO)
Lighting Control System	26 09 43	n-light Lutron Crestron
Identification	26 05 53	Ideal Industries, Inc. Panduit Corp. Seton Identification Product. Brady, Co.
Low-Voltage Distribution Transformers	26 22 13	Eaton ABB (GE) Siemens Schneider Electric (Square D)

TITLE	SPECIFICATION SECTION	MANUFACTURER
Switchboards Panelboards	26 24 13 26 24 16	Eaton ABB (GE) Siemens Schneider Electric (Square D)
Wiring Devices		
- Receptacles and Switches	26 27 26	Eaton (Cooper) Hubbell, Inc. Leviton Legrand (Pass & Seymour)
- Dimmers	26 27 26	Lutron Phillips
- Occupancy Sensors	26 27 26	Lutron Legrand (Wattstopper) Hubbell Sensorswitch
Connections	26 28 16	ABB (Thomas and Betts Corp.) Emerson (Appleton Electric) Hubbel (Burndy Corp.) Ideal Industries, Inc.
Fuses (See Note)	26 28 16	Eaton (Bussman) Mersen (Ferraz Shawmut) Littelfuse
Lightning Protection	26 41 13	nVent (Erico Lightning Protection) Robbins Lightning, Inc. Thompson Lightning Protection VFC/Lyncole
Surge Protection Device	26 43 13	Refer to Section
Addressable Fire Alarm System	28 46 00	Edwards System Technology JCI (Simplex Grinnell) Notifier Siemens
NOTE: Contractor shall submit fuse coordination for the entire electrical distribution if alternate manufacturer is used.		

PART 3 - EXECUTION - NOT USED.

END OF SECTION 26 05 03

SECTION 26 05 04 - FOOD SERVICE EQUIPMENT WIRING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General: Provide food service equipment wiring, complete, as shown and specified per Contract Documents.
- B. Related Sections: The following Sections apply to Work under this Section.
 - 1. Division 26 Section "Electrical Requirements" and "Basic Material and Methods".

1.2 GENERAL

- A. Obtain and verify electrical requirements and location of food service equipment prior to installation of related electrical Work.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Refer to Section 26 05 26 "Basic Material and Methods"

PART 3 - EXECUTION

3.1 FOOD SERVICE EQUIPMENT WIRING

- A. All final connections to equipment by Electrical Contractor.
- B. All electrical lines shall be extended from rough-in to connection point or points on the fixture by the Electrical Contractor furnishing all labor and materials.
- C. Where electrical lines are shown out of floor on drawings, Electrical Contractor shall stub up 6" above finished floor and connect, after equipment has been set in place and leveled by Kitchen Equipment Contractor (KEC).
- D. All rough-ins shall be concealed in walls or columns wherever possible.

- E. All fabricated equipment shall be completely wired internally, and all electrical outlets and receptacles mounted on or in fabricated equipment shall be furnished and installed by KEC who shall run all lines to suitable terminal boxes or subpanels; starters or disconnect switches by Electrical Contractor. Final connection shall be made by the Electrical Contractor. Where equipment wiring terminates in a junction box, switch, or terminal box, the Electrical Contractor shall make all connections between the branch circuit and equipment wiring. Where terminal is a receptacle, connect branch circuit to receptacle. Where terminal is a sub-panel, connect branch circuit to the mains of the sub-panel. All receptacles shall be furnished by Electrical Contractor, except those which are built into an item of equipment.
- F. Pre NEC 210.08(B), all single phase breakers within any food service space or portable cart rated 50 amps or less shall be GFCI type. All three phase breakers within any food service space rated 100 amps or less shall be GFCI type.
- G. All plug-in equipment receptacles shall be polarized. The Electrical Contractor shall provide the appropriate grounding type receptacles for all wall- and floor-mounted outlets to be used for plug-in equipment as noted on the drawings, with characteristics as noted. All plug-in equipment shall have the appropriate cord and plug set furnished and installed by the KEC. The KEC and Electrical Contractor shall coordinate their work so that the receptacles provided will match the specific plugs installed as part of the plug-in equipment, and any changes in cords and plugs or receptacles required in the field will be done at no cost to the Owner.
- H. The Electrical Contractor shall interwire equipment components where required, such as, ventilator control panels to ventilators, fans and detergent systems, and disposer control panels to disposer motors and solenoids.
- I. Electric switches with thermal overload protection will be mounted on the dishwashing machine by KEC or dishmachine manufacturer. Machine may be shipped to the job site in one or more sections. After machine is assembled by the KEC, the Electrical Contractor shall interconnect machine sections and provide final connections.
- J. The KEC shall supply, one each motor-driven appliance or electrical heating unit, a suitable control switch or starter of the proper type in accordance with Underwriter's Laboratory requirements wherever such switch or starter is not furnished integrally with the equipment by its manufacturer. All other line switches; safety cut-outs; disconnect switches; control panels; fuse boxes; other controls, fittings, and connections, when not an integral part of the unit, will be furnished and installed by the Electrical Contractor.
- K. All conduit, junction boxes, and other fittings for equipment which is freestanding, or open tubular construction, exposed to public view, shall be stainless steel or chrome plated. Assemblies in non-public areas shall be epoxy-painted aluminum.
- L. The Electrical Contractor shall supply power and interconnecting services and all final connections to walk-in refrigeration and freezer compressor/condensers and evaporators, solenoid valves and switches required for a complete operating system. Furnish and install a disconnect switch for each compressor. Walk-in refrigerator lights shall be furnished by the

KEC and installed and fully connected by the Electrical Contractor. Exposed conduit inside the walk-in compartment is unacceptable.

- M. The Electrical Contractor shall furnish and install control wiring between refrigeration temperature alarm systems and remote monitoring panel.
- N. "Sealtite" type flexible conduit shall be used for all flexible conduit installations, depending on code requirements. Junction boxes for equipment requiring flexible conduit should be mounted right on conduit at elevations which will limit the total length of the flexible conduit to 24" overall.
- O. Sleeve collars shall extend 2" above top of the finished floor. Openings between collar and conduit shall be sealed watertight.
- P. Electrical Contractor shall connect electrical supply from rough-in location to the disposer control panel and then to the disposer motor and solenoids. Control panel contains overload and under-voltage protection and fused disconnect switch.
- Q. The KEC shall provide microswitches as part of the fire suppression system, which, when wired to, will allow for the interruption of power to all electrically operated equipment and closed gas solenoid as required in case of fire. Power source for the fire suppression system shall be interwired to an external battery system by the Electrical Contractor so that the fire system will remain energized in the event of a power failure. The Electrical Contractor shall provide adequate contactors, shunt-trips, or other equipment to interrupt power as required by code and inter-wire with system as supplied by KEC. (If Utility Distribution System is specified, shut-offs will be provided by KEC as part of the system and the Electrical Contractor will need to interwire from the microswitch at the fire suppression system tanks to the terminal block in the system.)
- R. Electrical Contractor shall interwire ventilator exhaust and washdown system per directions of KEC and manufacturer. Ventilator exhaust system shall be interfaced with fire suppression system, such that when activated the ventilator exhaust shall become or remain operational. The ventilator control system shall be interwired to an emergency generator or external battery system so that the ventilator system is constantly energized in the event of a power failure.

END OF SECTION 26 05 04

SECTION 26 05 05 - ELECTRICAL DEMOLITION AND RELOCATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. This Section supplements Division 1, General Requirements. Where contradictions occur between this Section and Division 1, the more stringent of the two shall apply. The Architect shall decide which is more stringent.
- B. Requirements of the following Divisions and Sections apply to this Section:
 - 1. Division 26 Section 26 05 00 "Electrical Requirements."
 - 2. Division 9 Section "Painting" for related requirements.
- C. Refer to other Division 26 Sections for additional specific electrical demolition or relocation associated with specific items.

1.2 SUMMARY

- A. This Section includes basic requirements for demolition and relocation of electrical materials, equipment, and installations. The Contractor shall be responsible for visiting the site prior to bid to determine the actual conditions, which might affect the bid or contract price. No allowance will be made subsequently resulting from the neglect to visit the site and make such determinations.
- B. Generally, electrical items that are to be replaced with other equipment in the same location are work covered by this section. Also covered by this section are electrical items that are to be removed in their entirety or that are to be relocated to another place.

1.3 UTILITY SERVICES

- A. Maintain existing utility services. Where necessary to cut existing conduits, wires, cables, etc. of utility services or fire protection systems, they shall be cut and capped at suitable places or where directed by the Owner's representative.
- B. Electrical service in demolition area shall be reduced to a minimum and identified to eliminate uncertainty about which circuits are energized.
- C. The Contractor shall notify the Owner's representative in writing of any planned utility interruptions including interruptions of power to communications and fire protection systems at least 48 hours in advance or as otherwise specified. The request shall state the reason, date, beginning time, and expected duration of such interruptions. No interruptions shall be made

without the Owner's written concurrence and such interruptions shall be coordinated with the Owner to cause the least inconvenience to the Owner's operations. Service interruptions which cannot wait for written approval may be granted with verbal approval from the Owner's representative. After verbal approval is granted, written confirmation shall be issued by the Contractor as soon as practical.

1.4 PROTECTIVE MEASURES

- A. Provide the following protective measures:
 - 1. Wherever existing roofing surfaces are penetrated by electrical conduit, they shall be protected against water infiltration. Water leaks shall be repaired immediately upon discovery when they occur.
 - 2. Temporary protection against damage for all portions of existing structures and grounds where work is to be done, materials handled, and equipment moved or relocated.
 - 3. Contractor shall patch and fill openings in floors, walls and ceilings for removed equipment or piping with the same material, fire and structural integrity that would have existed prior to the penetration including concrete, block, gyp wallboard, exterior walls, roof membranes, etc. except for steel and wood beams which shall have the openings capped with similar material.
- B. The Contractor shall be responsible for contacting utilities or locating services and obtaining locations of all underground services in the general area of demolition work.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. The Contractor shall provide all equipment and materials necessary for the removal or relocation of electrical equipment.
- B. Materials used in restoration or repairing work related to demolition and relocation shall conform in type, quality, and function to that of the original existing construction or as otherwise indicated.

2.2 DISPOSAL AND RETENTION

- A. Materials and equipment resulting from work and removed from the building or structures, or parts thereof, shall become the property of the Contractor and shall be removed from the site by the Contractor except as follow:
 - 1. Light fixtures, lamps, and ballasts.
 - 2. Fire, heat, and smoke detection devices.

3. Telephones and telephone equipment other than outlet devices.
 4. Fire alarm notification devices and pull stations.
 5. Paging speakers, clocks, and intercom call stations.
- B. Items removed or noted to be retained by the Owner but which are declined to be retained by the Owner shall be removed from the site by the Contractor.
- C. Combustible waste material and rubbish shall not be stored or allowed to accumulate within a building or its vicinity, but shall be kept in a suitable trash container for subsequent removal or shall be removed from the premises as rapidly as practical.
- D. All hazard waste shall be properly disposed of by a licensed hazard waste disposal facility. Items shall include but not limited to fluorescent lamps, diesel fuel, radiator coolant, etc.

PART 3 - EXECUTION

- A. Remove or relocate all items indicated on the drawings or as otherwise indicated.
- B. Where the drawings indicate that equipment is to be replaced or where other equipment requires the relocation of existing equipment, the existing equipment shall be removed or relocated as though it was specifically noted to be removed or relocated.
- C. Wherever electrical materials have been removed from surfaces of the building or structure, those surfaces shall be patched and repaired.
- D. Remove, cut, alter, replace, patch, and repair existing work as necessary to install new work. Unless otherwise indicated or specified, do not cut, alter, or remove any structural members, ducts, piping, or service lines without approval of the Owner's representative.
- E. Existing work or equipment to be altered or extended and found to be defective shall be reported to the Owner's representative before it is disturbed or any further work is performed on it.
- F. Where electrical equipment is indicated to be removed or relocated, the work shall include the complete disconnection from its source, dismantling as necessary, and removal or installation of all conduit, wires, cables, etc. Unless noted otherwise, wires shall be removed from conduits back to the last utilization device or to the panelboard. No wiring shall be removed that prevents operation of other equipment not scheduled or indicated to be removed.
- G. Perform and schedule all demolition work with other trades and work of the contract as necessary for the efficient progress and flow of the work.

END OF SECTION 26 05 05

SECTION 26 05 10 - TESTING

PART 1 - GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

- A. Acceptance and startup testing requirements for electrical power distribution equipment and systems. Contractor shall retain and pay for the services of a recognized independent testing firm for purpose of performing inspections and tests as herein specified.
 - 1. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
 - 2. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
 - 3. The tests and inspections shall determine suitability for startup and energization.
 - 4. The following equipment shall be tested and calibrated:
 - Grounding and Bonding – Section 26 05 26
 - Low-Voltage Distribution Transformers – Section 26 22 13
 - Panelboards – Section 26 24 16
 - Distribution Switchboards – Section 26 24 16
 - Electrical Power Conductors and Cables – Section 20 05 19

1.2 SUBMITTALS

- A. Provide submittal per Contract General Conditions, Division 1, and Section 26 05 00.
- B. Qualification of testing firm.
- C. Submit one electronic copy of certified test reports to Engineer for approval.
- D. One electronic copy of blank forms for checklists, test reports, and other related forms for Engineer's review and approval.

1.3 GENERAL REQUIREMENTS

- A. The Contractor shall perform routine insulation resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to any acceptance testing.
- B. The Contractor shall test all lighting, low-voltage relays and circuits to ensure proper operating conditions prior to acceptance testing.

- C. The Contractor shall perform visual and mechanical inspections, verifying that the equipment nameplate information meets the intent of the drawings and specifications.
- D. The Contractor shall be responsible for all final settings and adjustments on protective devices and tap changes, submitting settings to the Architect/Engineer for review.
- E. Provide a complete short-circuit study, equipment interrupting/withstand evaluation, and a protective device coordination study for the electrical distribution system described herein. This study shall be submitted with electrical equipment submission and electrical room layouts.
- F. The Contractor shall engage the services of a recognized corporate and financially independent testing firm for the purpose of performing inspections and tests as herein specified.
- G. The firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
- H. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
- I. The tests and inspections shall determine suitability for energization. Equipment shall not be energized until accepted by the testing firm.

1.4 QUALIFICATIONS OF TESTING FIRM

- A. The testing firm shall be a recognized corporate and financially independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.
- B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
- C. The testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or be a Full Member company of the InterNational Electrical Testing Association (NETA).
- D. The lead, on-site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing.
- E. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing and engineering services. All studies, tests, and reports shall be sealed by a registered electrical professional engineer with a current Colorado stamp.

- F. The testing firm shall submit proof of the above qualifications with bid documents, when requested.
- G. The terms used herewith, such as test agency, test contractor, testing laboratory, or contractor test company, shall be construed to mean the testing firm.

1.5 APPLICABLE CODES, STANDARDS, AND REFERENCES

- A. All inspections and tests shall be in accordance with the following codes and standards except as provided otherwise herein:
 - 1. National Electrical Manufacturer's Association - NEMA
 - 2. American Society for Testing and Materials - ASTM
 - 3. Institute of Electrical and Electronic Engineers - IEEE
 - 4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-2009
 - 5. American National Standards Institute - ANSI C2: National Electrical Safety Code
 - 6. State and City of Steamboat Spring, CO Codes and Ordinances
 - 7. Insulated Cable Engineers Association - ICEA
 - 8. Association of Edison Illuminating Companies - AEIC
 - 9. Occupational Safety and Health Administration - OSHA
 - 10. National Fire Protection Association - NFPA
 - a. ANSI/NFPA 70: National Electrical Code
 - b. ANSI/NFPA 70B: Electrical Equipment Maintenance
 - c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
 - d. ANSI/NFPA 780: Lightning Protection Code
 - e. ANSI/NFPA 101: Life Safety Code
- B. All inspections and tests shall utilize the following references:
 - 1. Project design specifications.
 - 2. Project design drawings.
 - 3. Short-circuit and coordination study.
 - 4. Manufacturer's instruction manuals applicable to each particular apparatus.
 - 5. Project list of equipment to be inspected and tested as stated above.

PART 2 - SHORT-CIRCUIT, COORDINATION, AND ARC FLASH STUDIES

2.1 SHORT-CIRCUIT STUDY

The electrical equipment manufacturer shall perform a short-circuit analysis of the specified electrical power distribution system. This analysis shall include:

- A. Calculation of the maximum RMS symmetrical three-phase short-circuit current available at significant locations in the electrical system. The results shall represent the highest short-circuit currents to which the equipment might be subjected under the reported system conditions. The short-circuit currents shall be calculated with the aid of a digital computer. Appropriate motor short-circuit contribution shall be included in the calculation.
- B. The study shall include all portions of the electrical distribution system from the normal and alternate sources of power throughout the low-voltage distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly covered in the study.
- C. The study shall be calculated from the utility meter to the unit substation to the lowest overcurrent device or equipment on the electrical distribution system. The utility conductors shall not be used for calculations.
- D. An evaluation of the adequacy of the short-circuit ratings of the electrical equipment supplied by that manufacturer.
- E. Provide one electronic copy of the short-circuit analysis for the engineer's approval.
- F. A computer printout of input data, a computer printout of calculated results and an explanation of how to interpret the printouts.
- G. A one-line diagram identifying all bus locations and the maximum available short-circuit current at each bus.
- H. A bus-to-bus listing of the maximum available short-circuit current expressed in RMS symmetrical amperes and the X/R ratio of the fault current.
- I. A table of equipment short-circuit ratings versus calculated short-circuit current values.
- J. An analysis of the results in which any inadequacies shall be called to the attention of the Engineer and recommendations made for improvements. These recommendations shall be incorporated by the electrical equipment manufacturer to the electrical equipment at no cost to the Owner, where approved by the Engineer.

2.2 ARC FLASH HAZARD ANALYSIS

- A. Provide with the coordination and short circuit studies an Arc Flash study and device by device listing of PPE requirements and ratings as required by the NEC and NFPA 70E. All equipment shall have appropriate labeling installed in the field by the electrical contractor as determined by the study.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchgear, switchboards, panelboards, busway, etc.) where work could be performed on energized parts.

PART 3 - INSPECTION AND TEST PROCEDURES

3.1 PROCEDURE

- A. Testing firm to provide and comply with the following:
 - 1. Acceptance test procedures for each individual equipment listed in Part 1 of this section for Engineer review and approval prior to any test and after thorough evaluation of the system. Testing shall conform to the latest version of InterNational Electrical Testing Association (NETA) specifications and standards for electrical power distribution equipment and systems and manufacturer's instructions.
 - 2. Refer to each individual specification section for testing requirements and comply.
 - 3. Inspect installed equipment, record results and report any discrepancy and deficiency with contract documents and governing codes prior to testing. All results shall be submitted to the Engineer for approval.

3.2 SYSTEM FUNCTION TESTS

- A. General:
 - 1. Perform system function tests upon completion of equipment component tests as define in this specification. It is the purpose of system function tests to prove the proper interaction of all sensing, processing, and action devices.
 - 2. Implementation:
 - a. Develop test parameters for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements.
 - b. Test all interlock devices, and trip settings on breakers.
 - c. Record the operation of alarms and indicating devices.

3.3 DEFICIENCIES

- A. All deficiencies reported by testing firm to be corrected by Contractor and Acceptance Test to be re-done accordingly.

END OF SECTION 26 05 10

SECTION 26 05 19 - ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirement of the following Division 26 Sections apply to this section:
 - 1. Electrical Requirements

1.2 SUMMARY

- A. This Section includes wires, cables, and connectors for power, lighting, signal, control and related systems rated 600-Volts and less.
- B. Related Sections: The following Sections contain requirements that relate to this section:
 - 1. Division 31 Section "Earthwork" for trenching and backfilling.
 - 2. Division 26 Section "Electrical Boxes and Fittings" for connectors for terminating cables in boxes and other electrical enclosures.
 - 3. Division 26 Section "Raceways and Boxes" for MC cable, raceway and boxes.

1.3 SUBMITTALS

- A. Product Data for electrical wires, cables and connectors.
- B. Submit pulling tension calculations for all underground feeders.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with provisions of the following code:
- B. NFPA 70 "National Electrical Code."
 - 1. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.

- C. UL Compliance: Provide components, which are listed and labeled by UL under the following standards.
1. UL Standard 44 Rubber Insulated Wires and Cables
 2. UL Standard 83 Thermoplastic-Insulated Wires and Cables
 3. UL Standard 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
 4. UL Standard 854 Service Entrance Cable
 5. UL Standard 2196 Testing for Fire Resistive Cables
 6. UL Standard 1424 Cables for Power-Limited Fire-Alarm Circuits
- D. NEMA/ICEA Compliance: Provide components which comply with the following standards:
1. WC-5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 2. WC-7: Cross Linked Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- E. IEEE Compliance: Provide components, which comply with the following standard.
1. Standard 82: Test procedures for Impulse Voltage Tests on Insulated Conductors.

PART 2 - PRODUCTS

2.1 WIRES AND CABLES (600-VOLT COPPER CONDUCTORS)

- A. General: Provide suitable wire and cable for the temperature, conditions and location where installed. All wires and cables shall be new and delivered to the site in unbroken packages and reels.
- B. All wires and cables shall be of the same manufacturer throughout the entire project.
- C. Conductors: Provide solid conductors for power and lighting circuits #10 AWG and smaller. Provide stranded conductors for #8 AWG and larger.
- D. Conductor Material: All wires and cables shall be copper, single conductor rated at 600-Volts, which conform to or exceed ICEA specifications and the following:
1. In sizes 1/0 AWG to 4/0: Cross-linked polyethylene insulation type XHHW-2 (90°C) or THWN-2.
 2. In sizes 250 KCMIL and larger: Type XHHW-2 (90°C) or THWN.

3. In sizes 1 AWG and smaller: All conductors shall have heat/moisture resistant thermoplastic insulation type THWN-2 (90°C) except as follows:
 - a. Where conduit temperature will exceed 100°F, use type THHN (90°C).
 - b. In 120-Volt incandescent fixtures, type SF-2 or SFF-2 (150 - 200°C).
 - c. In wireway of fluorescent lighting fixtures type THHN (90°C).
- E. Rated Conductor Material: Where required by these specifications and code, provide 2-hour rated cable conforming to the following requirements:
 1. Cabling must meet current UL requirements for fire alarm resistance.
 2. Cabling must meet current NEC 700 and 760 requirements.
- F. Grounding conductors: Shall be of the same type as its associated phase conductors.
- G. All conductors shall be labeled with wire size, insulation rating, etc. using an engraved process, computer scan on labels are not permitted.
- H. Color Coding for phase identification in accordance with Table 1 in Part 3 herein.
- I. Connectors for Conductors:
 1. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.
 2. For wires that are #8 AWG and smaller: Insulated pressure type with live spring, rated 105°C, 600-Volt, for building wiring and 1000-Volt in signs or fixtures.
 3. For wires that are #6 AWG and larger: Compression type with 3M #33 or equal tape insulation.
- J. Splices and Taps:
 1. No. 10 AWG and smaller - Connectors for solid conductors shall be solderless, screw-on, spring pressure cable type, 600-Volt, 105°C with integral insulation and UL approved for aluminum and copper conductors. Connectors for stranded conductors shall be crimp-on type with integral insulating cover.
 2. No. 8 AWG and larger - Hydraulically applied crimping sleeve or tap connector sized for the conductors. Insulate the hydraulically applied connector with 90-degree, 600-Volt insulating cover provided by the connector manufacturer. Insulator materials and installation shall be approved for the specific application, location, voltage, and temperature and shall not have an insulation value less than the conductors being joined.

2.2 ALUMINUM WIRES AND CABLES (NOT ALLOWED)

PART 3 - EXECUTION

3.1 WIRING METHOD

- A. Use the following wiring methods as indicated:
 - 1. Install all wire in raceway. Power and control wiring shall be installed in separate raceways.

3.2 INSTALLATION OF WIRES AND CABLES

- A. General: Install electrical cables, wires, and connectors in compliance with NEC.
- B. Coordinate cable and wire installation with other Work.
- C. Do not install more conductors in a raceway than indicated on the drawings. A maximum of three ungrounded conductors are to be installed in any one conduit on a 3-phase, 4-wire system, unless specifically noted otherwise on the drawings. When more than three ungrounded conductors are installed in a raceway, the conductor size shall be increase per code for derating. No two ungrounded conductors of the same phase are to be installed in the same conduit, unless specifically noted otherwise on the drawings.
 - 1. Where multi-wire circuits are permitted by these specifications, all grounded and ungrounded conductors shall be grouped by wire markers, cable ties or similar means with the panelboard or wireway at least one location.
- D. Provide dedicated neutral conductor for all single phase circuits. Shared neutral conductor is not acceptable on single phase circuits.
- E. Minimum wire size shall be a No.12 AWG except for control or signal circuits, which may be No. 14 AWG.
- F. Unless otherwise indicated on drawings, all wiring for branch circuits shall be a minimum No. 12 AWG in ¾" conduit, protected by 20 amperes circuit breakers. If distance from panel to first outlet is 75 feet or greater for 120-Volt circuits, and 125 feet or greater for 277-Volt circuits, No. 10 AWG shall be installed throughout the circuit, unless noted otherwise on the drawings.
- G. Size of current carrying conductors, unless noted otherwise on drawings, shall be determined from Table 310.15(B)(16) of the latest National Electric Code for the load served.
- H. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.

- I. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.
- J. Size of conduits, unless specifically shown, shall be determined from Appendix C of the latest National Electrical Code.
- K. Keep conductor splices to a minimum. All splices shall be made within junction boxes, wiring troughs and other enclosures as permitted by the National Electrical Code.
 - 1. Splices shall not be permitted within 25 feet of any panel or electrical room.
 - 2. Do not splice conductors in panelboards, safety switches, switchboards, motor control centers or motor control enclosures.
 - 3. Splices in conductors installed below grade will not be permitted, unless approved in writing by the Architect and Engineer.
- L. Install splice and tap connectors, which possess equivalent or better mechanical strength and insulation rather than conductors being spliced.
- M. Use splice and tap connectors which are compatible with conductor material.
- N. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.
- O. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturers' published torque tightening values. Where manufacturers' torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque values specified in UL 486A and UL 486B. After tightening the connection/terminal, mark the bolt surface and that of the product or workpiece. Then loosen the bolt. Re-tighten it until the markings re-align. The torque needed to return the bolt to its original position is the torque value of the bolt.

3.3 FIELD QUALITY CONTROL

- A. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled.
- B. Prior to energizing, test wires and cables for electrical continuity and for short circuits.
- C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.
- D. Prior to completion of project, an infrared scan of switchgear and panelboard feeder equipment connection shall be performed when all loads are energized.

E. TABLE I: Color Coding for Phase Identification:

1. Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows:

<u>208V/120-Volts</u>	<u>Phase</u>	<u>480V/277-Volts</u>
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

3.4 FEEDER TESTING

A. Products

1. Material: Contractor shall provide all necessary testing equipment and devices required to perform the test described in this section.

B. Execution

1. Visual and Mechanical Inspection
 - a. Inspect cables for physical damage and proper connection in accordance with one-line diagrams.
 - b. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
 - c. Check cable color coding with specification section 26 05 53 and National Electrical Code standards.
2. Electrical Tests
 - a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000-Volts D.C. for 1 minute.
 - b. Perform continuity test to insure proper cable connection.
3. Test Values
 - a. Evaluate results by comparison with cables of same length and type. Investigate any insulation-resistance values less than 50 megohms.
 - b. Submit results to Engineer for approval in accordance with Section 26 05 10.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 26 Basic Materials and Methods sections apply to work of this section.
- C. Requirements of this section apply to electrical grounding and bonding work specified elsewhere in these specifications.

1.2 SUMMARY

- A. Extent of electrical grounding and bonding work is indicated by drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.
- B. Type of electrical grounding and bonding work specified in this section includes the following:
 - 1. Solidly grounded.
- C. Applications of electrical grounding and bonding work in this section includes the following:
 - 1. Underground metal piping.
 - 2. Underground metal water piping.
 - 3. Underground metal structures.
 - 4. Building frames - structural steel.
 - 5. Electrical power systems.
 - 6. Grounding electrodes.
 - 7. Separately derived systems.
 - 8. Raceways.
 - 9. Service equipment.
 - 10. Enclosures.
 - 11. Equipment.
 - 12. Lighting Standards.
 - 13. Landscape Lighting.
 - 14. Signs.

- D. Refer to other Division 26 sections for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work; not work of this section.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.
- B. Wiring Diagrams: Submit wiring diagrams for electrical grounding and bonding work which indicates layout of ground rods, location of system grounding electrode connections, routing of grounding electrode conductors, also include diagrams for circuits and equipment grounding connections.
- C. Submit ground riser diagram for entire project. Show bus bars with transformer ground electrode conductors, etc.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firms with at least 5 years of successful installation experience on projects with electrical grounding work similar to that required for project.
- C. Codes and Standards:
 - 1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.
 - 2. ANSI Compliance: C119.4 Electrical Connectors,
 - 3. UL Compliance: Comply with applicable requirements of UL Standards No.'s 467, "Electrical Grounding and Bonding Equipment", and 869 "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Standard 486A-486B, "Wire Connectors and soldering Lugs for Use with Copper Conductors." UL Standard 486C "Splicing Wire Connectors" UL1059 "Terminal Blocks. Provide grounding and bonding products which are UL-listed and labeled for their intended usage.
 - 4. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.

5. NFPA Compliance: NFPA 70 National Electrical Code, NFPA 780” Standard for the Installation of Lightning Protection Systems”

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials and Components:

1. Provide electrical grounding and bonding system; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is installer’s option. Where materials or components are not indicated provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.

2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductors, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductors.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Rectangular bars of annealed copper 1/4 by 3 by 12 inches (6 by 76 by 300 mm) in cross section, unless otherwise indicated; with insulators.

2.3 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

- B. Bolted Mechanical Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts. Of type recommended by ABB (Blackburn/Color-Keyed) Installation Products, (Burndy) Hubbell Inc or equal.
1. Pipe Connectors: Clamp type, sized for pipe.
- C. Irreversible Compression Connectors: Use for connections to structural steel and for underground connections except those at test well. Install connection to ground rods. Comply with manufacturer's written recommendations and training. Must be factory filled with an oxide inhibitor and installed with manufacturers recommend dies. The die index must match the listed index for the connector. Use of a 14 Ton or larger hydraulic compression tool to provide correct circumferential pressure for compression connectors and index die numbers are properly indented. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code method to make visible indication that the connector has been adequately compressed on the ground conductor, ground rod or ground plate. Irreversible compression connectors may be used below grade, above grade and concrete incased applications. Of types recommended by ABB (Blackburn) Installation Products, Burndy (Hubbell Inc). or approved equal.
- D. Welded Connectors: Exothermic-welding kits of types recommended by ABB (Furseweld) Installation Products, Burndy (Thermoweld) Hubbell Inc. Erico – nVent (Cadweld) (or approved equal) manufacturer for materials being joined and installation conditions. Exothermically welded connections are required on all grounding electrode conductors other than water pipes, all connections to building steel (connections to structural member), all grounding conductors run under the earth, connection to ground rods and in any case where grounding conductors are subject to a hostile environment.
1. The exothermic welding system furnished under these specifications shall meet the applicable requirements of IEEE80, Chapter 9, Section of conductors and joints.
 2. Molds shall be made from graphite or other material that is so designed to provide an average life of not less than 50 exothermic welds under normal conditions. Molds shall bear permanent marking, indicating the name of the manufacturer, the mold model, the type and size of welding mixture compatible with the welding process, and the size of the conductor. Instructions detailing general safety information, and welding procedures shall be provided with each mold.
 3. Starting material, if used, shall consist of aluminum and copper/copper oxide and iron oxides. It shall not contain phosphorous or any caustic, toxic or explosive substance. Weld metal used for grounding connections shall contain copper oxide, aluminum. Where welding is done in enclosed structures, the Erico Exolon smokeless system shall be used.
- E. Exothermic connections are to be performed by manufacturer's trained personnel with a qualification and/or training certificate on file with the contractor.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-bonded steel; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.
 - 1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
 - 2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No.10 AWG and smaller, and stranded conductors for No.8 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned copper conductor, No.3/0 AWG minimum.
 - 1. Bury at least 24 inches (600 mm) below grade. In areas subject to long term and deeper freezing a lower depth may be in order.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
 - 3. Copper Ground Loop: Bury a minimum of 30" below grade.
- C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.
- E. Comply with IEEE C2 grounding requirements
 - 1. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding

electrodes. Install tinned-copper conductor not less than No.3/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits. The conduit shall not be acceptable as an equipment ground.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. Protection:
 - 1. All grounding electrode conductors smaller than #6 AWG shall be routed in conduit – EMT or Rigid/IMC if exposed to damage or weather.
 - 2. All grounding electrode conductors #6 AWG and larger shall be routed in conduit – EMT or Rigid/IMC if exposed to weather.
- D. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- E. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- F. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 EXAMINATION

- A. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.4 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

- A. General: Install electrical grounding and bonding systems in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.
- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.
- C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- D. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96A when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- E. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 - 2. For grounding electrode system, install at least three rods, spaced at least one-rod length from an adjacent grounding means (such as Ufer, building steel or cold water pipe). AND/OR two-rod lengths from an adjacent rod (i.e. 16' apart for 8' rods & 20' apart for 10' rods), and connect to the service grounding electrode conductor.
- F. Test Wells: Provide test wells as required by the NEC.
 - 1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

- G. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment
 3. Use exothermic-welded connectors or irreversible compression connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- H. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, each unit substation, or each main electrical room grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- I. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- J. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
- K. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
1. Install tinned-copper conductor not less than No.4/0 AWG for ground ring and for taps to building steel.
 2. Bury ground ring not less than 24 inches (600 mm) from building foundation.
- L. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet (6m) of bare copper conductor not smaller than No. 4/0 AWG.
1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

- M. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- N. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.
- O. Install all connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

3.5 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this section:
 - 1. “Electrical Requirements.”

1.2 SUMMARY

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
- B. Related Sections: The following Sections contain requirements that related to this Section:
 - 1. Division 3 Section “Mild Steel Concrete Reinforcement” for inserts, anchors, and sleeves to be installed in concrete for use with supporting devices.
 - 2. Division 5 Section “Metal Fabrications” for requirements for miscellaneous metal items involved in supports and fastenings.
 - 3. Division 7 Section “Firestopping” for requirements for firestopping at sleeves through walls and floors that are fire barriers.
 - 4. Refer to Division 26 Sections for additional specific support requirements that may be applicable to specific items.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified.
 - 1. Hanger and support schedule showing manufacturer’s figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.
- C. Shop drawings indicating details of fabricated products and materials.

- D. Engineered Design consisting of details and engineering analysis for supports for the following items:
1. Conduit (racked)
 2. Ceiling-mounted boxes, transformers.
 3. Conduit - Ceiling mounted, concrete encased.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 “National Electrical Code.”
- B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.
- C. Installation shall comply with local authorities seismic requirements.

PART 2 - PRODUCTS

2.1 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized and where installed in corrosive atmosphere, stainless-steel type channel and hardware shall be used.

2.2 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads. Aircraft cable and other non-rigid supports shall not be permitted for use as supporting material for conduit.
- C. Fasteners: Types, materials, and construction features as follows:
1. Expansion Anchors: Carbon steel wedge or sleeve type.
 2. Toggle Bolts: All steel springhead type.
- D. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls.

Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

- E. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- F. U-Channel Systems: 16-gauge steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.3 FABRICATED SUPPORTING DEVICES

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with the NEC and the following requirements:
 - 1. Conform to manufacturer's recommendations for selection and installation of supports.
 - 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
 - 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - 4. Support parallel runs of horizontal raceways together on trapeze-type hangers. All supporting rods shall be rigid. Aircraft cable and other similar non-rigid cable shall not be used to support horizontal conduit.
 - 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1 1/2 inch and smaller raceways serving lighting

- and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch diameter or larger threaded steel. Use spring fasteners that are specifically designed for supporting single conduits or tubing.
6. Space supports for raceway in accordance with NEC.
 7. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, supports at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples of threadless box connectors.
 8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
- D. Vertical Conductor Supports: Install simultaneously with installation of conductors (i.e., strain reliefs).
1. Support shall be at each individual conductor.
- E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to the raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
- G. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and wall for raceways and cable installations. For sleeves through fire-rated wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with "Fire Stopping" requirement of Division 7.
- H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions or light steel construction, use sheet metal screws.

2. Holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.
- J. TESTS: Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:
1. Expansion anchors.
 2. Toggle bolts.
- K. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.
- B. Requirements of the following Division 26 Sections apply to this Section:
 - 1. "Electrical Requirements."
 - 2. "Basic Material and Methods"

1.2 SUMMARY

- A. Drawings are diagrammatic. All bends, boxes, fittings, couplings are not necessarily shown. Supply as necessary to comply with the National Electric Code.
- B. Provide complete raceway systems for all conductors including control wiring and low-voltage wiring unless otherwise noted.
- C. This Section includes raceways for electrical wiring. Types of raceways, boxes and fittings in this section include the following:
 - 1. Electrical metallic tubing (EMT).
 - 2. Flexible metal conduit.
 - 3. Intermediate metal conduit (IMC).
 - 4. Liquid-tight flexible conduit.
 - 5. Rigid metallic conduit (RMC).
 - 6. Metal clad cable (MC).
 - 7. Surface raceways.
 - 8. Rigid non-metallic conduit.
 - 9. Electrical non-metallic tubing (ENT)
 - 10. Wireway.
 - 11. Outlet boxes.
 - 12. Junction boxes.
 - 13. Pull boxes.
 - 14. Bushings.
 - 15. Locknuts.
 - 16. Knockout closures.

- D. Related Sections: The following section contains requirements that relate to this section:
 - 1. Division 26 Section "Raceway and Boxes" for conduit connectors, fittings, and couplings.
 - 2. Division 7 Section "Firestopping" for conduit penetrations through rated walls and slabs.
- E. Section only applies for electrical systems to be installed within raceways. This excludes beverage piping and pneumatic systems pulled within raceways.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of contract and Division 1 Specification Section.
- B. Product Data for the following products:
 - 1. Raceways and fittings.
 - 2. Wireways and fittings.
 - 3. Boxes and fittings.
- C. Installation Instructions: Manufacturer's written installation instructions for wireway, surface raceway, and nonmetallic raceway products.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
- C. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL.
- D. Manufacturers: Firms regularly engaged in manufacture of electrical boxes and fittings, of types, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than five years.
- E. Installer's Qualifications: Firms with at least five years of successful installation experience on projects utilizing electrical boxes and fittings similar to those required for this project.
- F. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.

- G. UL Compliance: Comply with applicable requirements of UL 50, UL 514-Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings which are UL-listed and labeled.
- H. NEMA Compliance: Comply with applicable requirements of NEMA Standards/Pub No.'s OS1, OS2 and PUB 250 pertaining to outlet and device boxes, covers and box supports.
- I. Federal Specification Compliance: Comply with applicable requirements of FS W-C 586, "Electrical Cast Metal Conduit Outlet Boxes, Bodies, and Entrance Caps."

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1
- B. PVC Coated Rigid Galvanized Steel Conduit: ANSI C80.1, UL6 & NEMA RN-1 2018
- C. Intermediate Steel Conduit: UL 1242.
- D. Electrical Metallic Tubing and Fittings: ANSI C80.3.
- E. Flexible Metal Conduit: UL 1, zinc-coated steel.
- F. Liquid-tight Flexible Metal Conduit and Fittings: UL 360.

2.2 METAL CLAD CABLE, TYPE MC

- A. The multi-conductor metal clad cable shall comply with UL 1569 "Metal Clad, Type MC," UL 83 "Thermoplastic Insulated Wires and Cables" Federal Specification J-C-30B "Wire and Cable," Local and National Electrical Codes.
- B. The metal clad cable shall be THHN insulation, copper conductors in sizes #12 through #8 AWG only for continuous operation at a maximum conductor temperature of 90 degree C dry.
- C. These cables shall bear appropriate Underwriters Laboratories labels for metal clad cable and be suitable for use as branch circuits in both exposed and concealed work in accordance with applicable sections of the National Electrical Code.
- D. An insulated grounding conductor sized in accordance with Table 5.3 Underwriter's Standard UL 1569 shall be cabled with the circuit conductors and shall be identified in compliance with Section 29 of UL 1569. The grounding conductor shall not be smaller than size indicated in NEC Article Table 250.122.

- E. A galvanized steel or aluminum armor shall be applied over the inner cable assembly with a positive interlock in compliance with Section 10 of UL 1569. MC cable with a PVC jacket shall not be permitted to be installed in slabs.

2.3 CONDUIT BODIES AND FITTINGS

- A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways.
- C. EMT Conduit Bodies 1 Inch and Smaller: Use bodies with steel set screw connectors and couplings for interior applications and steel compression gland connectors and couplings for exterior applications.
- D. EMT Conduit Bodies 1 Inch and Larger: Use bodies with steel set screw connectors and couplings for interior applications and steel compression gland connectors and couplings for exterior applications.
- E. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL514B.
- F. PVC Coated RGS Conduit Bodies: Conduit bodies shall have a nominal 40mils of PVC and 2mils of interior urethane and shall be NEMA 4X listed with encapsulated stainless-steel screws.
- G. Liquid-Tight Flexible Conduit Fittings: With threaded grounding cone, steel, nylon or equal plastic compression ring, and a gland for tightening. Either steel or malleable iron only with insulated throats and male thread and locknut or male bushing with or without O-ring seal. Each connector shall provide a low resistance ground connection between the flexible conduit and the outlet box, conduit or other equipment to which it is connected.
- H. Bushings: Insulated type, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system, for rigid steel conduit, IMC and EMT, larger than 3/4" size.
- I. Expansion Fittings: Each conduit that is buried in or secured to the building's construction on opposite sides of a building expansion joint and each long run of exposed conduit that may be subject to excessive stresses shall be provided with an expansion fitting. Expansion fittings for rigid steel conduit shall be hot-dipped galvanized malleable iron with factory installed packing and a grounding ring and internal bonding jumper. Expansion fittings for rigid non-metallic conduit shall be of the short type in runs 25' or less, and the long type in runs 26' to 80'. The long type shall be a two-piece barrel and piston joint, providing 6" of the total movement range in 3/4" through 6" conduit sizes. The short type shall be a one piece, coupling with O-ring, providing 2" of total movement range in 3/4" to 2" conduit sizes.

- J. Seal Off Fittings: Refer to section 26 05 02 for additional requirements.
- K. Sleeves for Conduit Penetration: Refer to section 26 05 02 for additional requirements.

2.4 WIREWAYS

- A. General: Electrical wireways shall be of types, sizes, and number of channels as indicated. Fittings and accessories including but not limited to couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of NEC.
- B. Wireway covers shall be hinged type.

2.5 SURFACE RACEWAYS

- A. General: Sizes and channels as indicated on drawings. Provide fittings that match and mate with raceway. Provide internal barriers for areas with power and communications sections.
- B. Surface Metal Raceway: Construct of two-piece galvanized steel with snap-on covers, with 9/32-inch mounting screw knockouts in base approximately 8 inches o.c. Finish with manufacturer's standard prime coating suitable for painting. Provide raceways of types suitable for each application required. Sizes 1-3/4" H x 4-3/4" W.
- C. Accessories:
 - 1. Couplings for joining raceway sections.
 - 2. Wire clips for conductors.
 - 3. Blank end fittings.
 - 4. Circuit breaker housings for single pole breakers.
 - 5. Device brackets for single or two gang devices.
 - 6. Combination receptacle and tele/data outlet covers.
 - 7. Outlet boxes with hubs for conduit connectors.

2.6 FABRICATED MATERIALS - BOXES

- A. Outlet Boxes: Provide galvanized flat rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes (minimum 4-inch square, 1 1/2-inch deep), including box depths as required, suitable for installation at respective locations. Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides. Provide boxes

with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.

1. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.
- B. Device Boxes: Provide galvanized coated flat rolled sheet-steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes (minimum 4-inch square, 1 1/2-inches deep), including box depths as indicated, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with conduit-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide conduit connectors and corrosion-resistant screws for equipment type grounding.
 1. Device Box Accessories: Provide device box accessories as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster ears, and plasterboard expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.
- C. Raintight Outlet Boxes: Provide corrosion-resistant cast-metal raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, cast-metal face plates with spring-hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners.
- D. Junction and Pull Boxes: Provide code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless-steel nuts, bolts, screws, and washers. Pull boxes installed in finished spaces must be flush-mounted cabinets provided with trim, hinged door and flush latch and lock to match flush-mounted panelboard trim. Provide galvanized code-gauge steel where required for outdoor exposure.
- E. Exterior junction or pull boxes, flush with grade:
 1. All exterior pull box locations shall be submitted and approved by landscape architect prior to installation.
 2. Junction or pull box to be mounted flush with grade shall be polymer composite raintight with screw cover lids. Box dimensions shall be 30"W x 48"L x 36"D. Covers shall be polymer composite suitable for pedestrian traffic secured to box with stainless-steel screws. Box to be furnished with continuous neoprene gasket to seal cover. Conduit entry shall be on side of box with bell ends.
- F. Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

PART 3 - EXECUTION

3.1 WIRING METHOD

A. Outdoors: Use the following wiring methods:

1. Exposed: Intermediate metal conduit, rigid steel conduit, raintight box.
2. Concealed: Intermediate metal conduit, rigid steel conduit.
3. Underground, Single Run: Rigid non-metallic conduit. PVC coated GRC 90° elbows.
4. Underground, Grouped: Rigid non-metallic conduit. PVC coated GRC 90° elbows.
5. Connection to Vibrating Equipment including transformers, pneumatic or electrical solenoid, and motor-operated equipment: Liquid-tight flexible metal conduit.

B. Indoors: Use the following wiring methods:

1. Exposed (below 10 ft. to floor): Intermediate metal conduit, rigid steel conduit.
2. Exposed (above 10ft. or in electrical room): Electrical metallic tubing.
3. Concealed: Electrical metallic tubing.
4. Concealed: Metal clad cable will be allowed as final branch wiring of receptacles (maximum total length of 25' from homerun J-box or hard piped J-box to first outlet on circuit). MC is not allowed for homeruns to panels, connections to mechanical equipment. Maximum conductor size is in MC cable #8 AWG. MC is acceptable for final light fixture connection, maximum 6' length.
5. Connection to Vibrating Equipment including transformers, pneumatic or electrical solenoid, and motor-operated equipment: Flexible metal conduit.
6. Connection to Vibrating Equipment in Moist/Humid or Corrosive Atmosphere including pneumatic or electric solenoid, and motor-operated equipment: Liquid-tight flexible metal conduit.
7. Within concrete slabs: Rigid non-metallic conduit. PVC coated MC cable and ENT is not allowed. Homeruns shall be in conduit. Maximum sizes and locations as approved by the Structural Engineer.
8. Raceway mounted to underside of metal-corrugated sheet roof decking shall be Rigid Metal Conduit or intermediate Metal Conduit.
9. Exposed Wet Locations: Intermediate metal conduit, rigid steel conduit, raintight box.
 - a. Provide conduit bodies or exterior boxes with a minimum of 1/8" drain. Drain shall be located to allow exterior raceway system to drain.
10. Corrosive Environment, including areas where pool equipment is installed or areas where chemicals are stored: Rigid Metal Conduit, intermediate Metal Conduit, PVC fiberglass.

3.2 INSTALLATION OF RACEWAYS

- A. General: Install electrical raceways in accordance with manufacturers' written installation instructions, applicable requirements of NEC, and as follows.

- B. Electrical system layouts indicated on drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from architectural drawings.
- C. All home runs to panelboards are indicated as starting from the outlet nearest to the panel and continuing in the general direction of that panel. Continue such circuits to panel as though routes were completely indicated.
- D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of the Architect, and conform to all structural requirements when cutting or boring structure.
- E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc., required for equipment specified under this Section.
- F. Minimum size conduit shall be 3/4" for power circuits and 1" for telecommunications devices.
- G. Conceal conduit and EMT, unless indicated otherwise, within finished wall, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.
- H. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping.
- I. Complete installation of electrical raceways before starting installation of conductors within raceways.
- J. Provide supports for raceways as specified elsewhere in Division 26 and in accordance with NEC and local authorities' seismic requirements.
- K. Prevent foreign matter from entering raceways by using temporary closure protection.
- L. PVC coated rigid galvanized steel conduit systems: Provide onsite installation training course by company representative. The representative shall conduct onsite training course to qualify for the installation certificate. After the onsite training installation, the representative shall then register the installer in his data base and provide certification for installation.
- M. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab. All elbow penetration through the slab shall be PVC coated rigid metallic conduit Ells. Where elbows end below the slab, extend PVC coated rigid conduit a minimum of 6 inches above the finished slab.
- N. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

- O. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings except as otherwise indicated.
- P. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.
- Q. Raceways embedded in slabs shall only be permitted with the strict written approval of the Structural Engineer and Architect. For bidding purpose, conduit shall not be permitted in slab.
- R. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. All exposed conduit runs shall be approved by the Architect prior to installing.
- S. All exposed conduits in public areas shall be painted to match surrounding walls. Verify exact color with the Architect. Coordinate painting of all exposed conduits with Construction Manager / General Contractor.
- T. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways are of the same size. In other cases, provide field bends for parallel raceways. All exposed conduit routing shall be approved by the Architect prior to installing.
- U. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Use expansion fittings at building expansion joints.
- V. Tighten set screws of threadless fittings with suitable tool.
- W. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside of the box. All conduit connections to junction boxes shall have insulated bushings.
- X. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
- Y. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave no less than 12 inches of slack at each end of the pull wire.

- Z. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Fitting should come complete with O-ring gasket. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
1. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces, air-conditioned spaces and walk-in coolers.
 2. Where required by the NEC.
- AA. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs flush with floor.
- BB. Flexible connection: Use length (maximum of 6 ft.) of flexible conduit for recessed and semi-recessed lighting fixtures, for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid-tight flexible conduit in wet locations. Install separate equipment grounding conductor across flexible connections.
- CC. Install nonferrous conduit or tubing for circuits operating above 60 Hz.
- DD. PVC externally coated rigid steel conduit: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.
- EE. All underground conduits shall be installed a minimum of 48 inches below finish grade for medium-voltage feeders and 30 inches for 480-Volt feeders. All other conduits shall be installed in accordance with the NEC and coordinated depth with other trades.
- FF. Grounding: Install a separate green equipment grounding conductor in all raceways from the panelboard/junction box supplying the raceway to the receptacle or equipment ground terminals. Conduits will not be permitted as a ground conductor.
- GG. Clearances: All electrical raceways shall be routed to maintain appropriate clearances from low-voltage raceways per NEC, ANSI/EIA/TIA, and BICSI requirements. Provided below are minimum requirements of key components that shall be maintained. For any instances where field conditions do not allow for the minimum clearances, the Contractor shall notify the Architect and Engineer so that an acceptable solution can be coordinated.
1. 120V Power Conduits: 6 inches (150mm)
 2. 208V and Higher Power: 24 inches (600mm)
 3. Lighting System: 12 inches (300mm)
 4. Transformers: 48 inches (1200mm)
 5. Motors and Fans: 48 inches (1200mm)

6. Other Interfering Sources to be field verified and coordinated by Contractor with Architect and Engineer.

HH. Support: All electrical raceways shall be independently supported. Support from suspended ceiling elements is not permitted.

3.3 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

- A. General: Install electrical boxes and fittings in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.
- B. Dimensions unless shown on drawings are given below and are from finished floor to center line of outlets unless noted otherwise. Adjust heights of outlets in masonry walls to correspond with consistent brick or block course. Outlets in block walls shall be installed in core of block.

Wall Switches	4' - 0" (to top of box)
Convenience outlets	1' - 4" (to bottom of box) – gyp or 8" block
	1' - 6" (to bottom of box) – 6" block
Panelboards wall mounted	6' - 6" (to top of back box)
Wall phone outlet	4' - 0" (to top of box)
Fire alarm horns, speakers	ceiling or wall
Fire alarm pull stations	4' - 0" (to top of device)
Fire alarm strobes	6' - 8" or 6" below ceiling (whichever is lower)

Confirm final location and heights of all outlets, wall switches, and television outlets with architectural drawings and furniture plans prior to installation.

- C. Exact location of outlets and equipment shall be governed by structural conditions and obstructions or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment. Verify final location of all outlets, panels, equipment, etc., with the Architect/Engineer.
- D. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
- E. Provide zinc-coated or cadmium-plated sheet steel outlet boxes not less than 4" octagonal or square, unless otherwise noted. Equip fixture outlet boxes with 3/8" no-bolt fixture studs. Where fixtures are mounted on or in an accessible type ceiling, provide a junction box and extend flexible conduit to each fixture. Outlet boxes in finished ceilings or walls shall be fitted with appropriate covers, set to come flush with the finished surface. Where more than one switch or device is located on one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted.

- F. Provide tile box or a 4" square box with tile ring in masonry walls which will not be plastered or furred, or where "dry-wall" type materials are applied. Through the wall type boxes are not permitted. Install minimum 12" lateral separation for back to back boxes.
- G. Provide outlets in rain tight box with metallic "in use" covers for interior and exterior locations exposed to weather or moisture.
- H. Provide rain tight box for all interior, exterior and non-conditioned locations exposed to weather or moisture. This includes boxes located under overhangs not directly exposed to moisture.
- I. Surface-mounted devices are to be mounted in cast type boxes with gasketed covers: (Crouse-Hinds FS/FD or equal).
- J. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- K. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.
- L. Electrical Contractor to provide access panels for electrical boxes which are code required to have accessibility.
- M. Installing boxes back-to-back in walls shall not be permitted. Provide no less than 12 inches (150 mm) of separation.
- N. Position recessed outlet boxes accurately to allow for surface finish thickness.
- O. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surfaces.
- P. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embedded electrical boxes in concrete or masonry.
- Q. Provide electrical connections for installed boxes.
- R. Exterior junction or pull boxes shall be mounted flush with grade, unless noted otherwise or indicated to be above ground on the drawings. Boxes shall be surrounded on all sides with 6 inches minimum of concrete. Top of concrete shall flush with grade. Seal all conduit entries into box with duct seal to prevent entrance of moisture, after conductors are installed.
- S. Tap and splices, where permitted by these specifications within exterior junction boxes, shall be performed with an encapsulating watertight splice or tap kit which insulates and moisture seals the connection. Kit shall consist of the appropriate size and type mold, encapsulating resin and end sealing tape.
- T. Subsequent to installation of boxes, protect boxes from construction debris and damage.

- U. Provide a standard access panel having a hinged metal door neatly fitted into a flush metal trim, where a junction box or equipment is located above non-accessible ceilings or behind finished walls. Coordinate location and type with the Architect.
- V. Outlets except over counters, benches, special equipment, baseboards, fin tube radiators, etc., or at wainscoting, shall be at a height to prevent interference to service equipment, or as noted on drawings.

3.4 GROUNDING

- A. Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

3.5 ADJUSTING AND CLEANING

- A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris. Swab all raceways that were not sealed or subject to water infiltration during construction.

END OF SECTION 26 05 33

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract.
- B. Materials and Methods, Sections of Division 26.
- C. Excavating, backfilling and Compacting and Division 3, concrete.
- D. All excavation is unclassified.
- E. Definitions:
 - 1. Engineer: Soils Engineer employed by Owner and empowered to undertake necessary inspections and approvals.
 - 2. Unclassified excavation: Excavate and grade all materials that can be removed without drilling or blasting.

1.2 SUMMARY

- A. Furnish all labor, materials, tools, equipment, and services for all underground service and manholes as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of all other trades.
- C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

1.3 SUBMITTALS

- A. Product data for the following: Electrical and Telecommunication Manholes, Duct Spacers.
- B. Test reports as required for compaction and concrete work in Division 2, 3, and 31.
- C. Submit pulling tension calculations for all underground feeders.
- D. Site plan identifying all pull boxes located on the site. The submittal shall identify the size of box, color of box, and intended services for the box (power, lighting, technology, future, etc.)

1.4 QUALITY ASSURANCE

- A. Compaction density test: ASTM D1557.
- B. Owner will hire an independent soils laboratory to conduct in place moisture-density tests to ensure that all work complies with this specification.
 - 1. Notify Construction Manager or Owner's representative at least 2 weeks prior to anticipated date of testing.
 - 2. Contractor will pay additional cost if work is delayed due to their failure to notify Owner's agent as specified above.
- C. Comply with all aspects of "Safety Rules & Regulations for Excavation: as promulgated by the state in which excavation will occur.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Store conduit to avoid warping or deterioration.
- B. Store plastic conduit on flat surface protected from direct rays of sun.

PART 2 - PRODUCTS

2.1 DUCT SYSTEM

- A. Duct System: Multiple and single, conduits completely encased in concrete.
 - 1. Separators: Plastic or other non-metallic, non-decaying material.
 - 2. Concrete: 3000 PSI. Conform to Division 3 requirements.
 - 3. Continuous tracing ribbon a minimum 12' below dirt surface.
- B. Pull Wire: No. 9 galvanized iron, or heavy nylon cord, free of kinks and splices.

2.2 PULL BOXES

- A. Site Pull Boxes
 - 1. Site landscape pull boxes shall be constructed of HDPE.
 - 2. Pull boxes located in concrete drives, sidewalks, etc. shall be precast type with drive over lids.
 - 3. Landscape box and cover shall be black unless otherwise specified by Landscape Architect.

PART 3 - EXECUTION

3.1 DUCT BANK

- A. Form all duct banks in square or rectangular fashion as shown, and place concrete so that voids around ducts are filled.
- B. Adjust final slopes on-site to coordinate with utilities and structure.
- C. Install drain assembly with saddle cutouts for each conduit. Tape drain assembly to each conduit to prevent entrance of concrete. Band drain assembly with ½-inch stainless-steel straps to conduit assembly to prevent mechanical displacement. Connect to (piping drain) washed gravel sump 36-inch square by 36-inches deep.
- D. Install on undisturbed soil where possible. Use pit run gravel and sand, placed in 8-inch lifts and compacted for backfill.
- E. After installation, clean and swab ducts.
- F. Install galvanized steel pullwires in spare ducts. Cap empty ducts with screw covers.
- G. Label conduit at stub-up and manhole penetrations in accordance with Section 26 05 53.

3.2 PULL BOXES

- A. All pull boxes shall be sized to accommodate all incoming and outgoing conduits.
- B. All pull boxes located in landscape areas shall include a gravel base to allow for drainage. Pull boxes shall not be installed in the paving unless specifically identified in the drawings/specifications or approved during submittal identifying pull box locations.

END OF SECTION 26 05 43

SECTION 26 05 48 - VIBRATION AND SEISMIC CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the drawings and as specified herein to provide complete vibration isolation systems in proper working order.

1.2 MATERIAL AND EQUIPMENT

- A. All vibration isolation mounts shall be supplied by one of the approved manufacturers stated in the PRODUCTS Section of this specification. Substitutions of equal equipment beyond the alternatives listed will be permitted only with the written permission of the Architect. Accompany each request for acceptance of substitute equipment with manufacturer's certified data proving the equivalence of the proposed substitute in quality and performance. The Architect shall be the final judge of the validity of the data submitted.
- B. Unless otherwise specified, supply only new equipment, parts, and materials.

1.3 SUBMITTALS

- A. Refer to related sections elsewhere for procedural instructions for submittals.
- B. The shop drawing submittal for isolated electrical equipment shall include submittal information for the isolation mounts. Information supplied shall be as follows:
 - 1. A complete description of products to be supplied including product data, dimensions, specifications, and installation instructions.
 - 2. Detailed selection data for each vibration isolator supporting equipment, including:
 - a. The equipment identification mark.
 - b. The isolator type.
 - c. The actual load.

3. Routt County is currently identified as a Seismic Category C. Provide seismic bracing/support for applicable building(s) with an importance factor above 1.0 as defined by the IBC. Detailed selection data for seismic restraints for buildings including:
 - a. Submit manufacturer's data for all manufactured restraints.
 - b. All submittals shall be stamped and certified by a Structural Engineer registered in the State of Colorado with a minimum of 5 years experience in the design of seismic restraints.
 - c. Submit shop drawings for all fabricated restraints.
 - d. Show restraint type and location on the installation shop drawings. Drawings to include:
 - 1) All seismic brace locations.
 - 2) All seismic restraint connections to structure and vertical support anchorage at seismic locations and all other vertical support anchorage connections. Including but not limited to Quantity, Size, and Embedment.
 - 3) Brace reaction at all connection points to the structure for Structural Engineer of Record use in checking suitability of the building structure.
 - 4) Type and size of brace member.
 - 5) Suspended utility maximum lbs. per linear foot or maximum conduit size at all seismic locations.
 - 6) Minimum all thread rod size at all seismic locations.
 - 7) Size all horizontal support members taking into account, but not limited to, deflection and load.
 - 8) Registered Colorado Engineer stamp and signature.
 - e. Submit calculations for all seismic restraint systems that are not preapproved.
 - f. Job site conditions not covered by the manufacturer's seismic bracing guidelines shall be engineered by the manufacturer.
- C. Submission of samples may be requested for each type of vibration isolation device. After approval, samples will be returned for installation at the job. All costs associated with submission of samples shall be borne by the Contractor.

1.4 QUALITY ASSURANCE

- A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- B. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified requirements.
- C. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim for additional payment.

- D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
- E. Should any electrical equipment cause excessive noise or vibration, the Contractor shall be responsible for remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.
- F. Upon completion of the work, the Architect or Architect's representative shall inspect the installation and shall inform the installing contractor of any further work that must be completed. Make all adjustments as directed by the Architect that result from the final inspection. This work shall be done before vibration isolation systems are accepted.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION MOUNT TYPES

A. Type DNP (Double Neoprene Pad):

- 1. Neoprene pad isolators shall be formed by two layers of 1/4" to 5/16" thick ribbed or waffled neoprene, separated by a stainless-steel or aluminum plate. These layers shall be permanently adhered together. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
- 2. Type DNP isolators shall be formed from one of the following products or approved equal:

Type NR	Amber/Booth
Type Korpad	Korfund Dynamics
Type WSW	Mason Industries
Type NPS	Kinetics Noise Control
Series Shear Flex	Vibration Mountings & Control

B. Type HN (Hanger Neoprene):

- 1. Vibration isolation hangers shall consist of a neoprene-in-shear or glass fiber element contained in a steel housing. A neoprene neck bushing (or other element) shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30° arc before contacting the hanger housing.
- 2. Type HN isolators shall be one of the following products or approved equal:

Type BRDA	Amber/Booth
Type H	Korfund Dynamics
Type HD	Mason Industries
Type RH or FH	Kinetics Noise Control
Type RHD or RFD	Vibration Mountings & Control

2.2 FLEXIBLE ELECTRICAL CONNECTIONS

A. Type A:

1. Flexible Electrical Connection Type A shall be a prefabricated unit incorporating a flexible and watertight outer jacket, grounding strap, plastic inner sleeve to maintain smooth wireway, and end hubs with tapered electrical threads to fit standard threaded rigid metal conduit.
2. Flexible Electrical Connection Type A shall be Crouse-Hinds (Syracuse, NY) "XD Expansion/Deflection Coupling," Spring City Electrical Mfg. Co. (Spring City, PA) "Type DF Expansion and Deflection Fitting," or approved equal.

B. Type B:

1. Flexible Electrical Connection Type B shall be field fabricated using a minimum 2 (two) foot length of flexible conduit or cable.

C. Type C:

1. Flexible Electrical Connection Type C shall be field fabricated using a minimum 4 (four) foot length of flexible conduit or cable.

PART 3 - EXECUTION

3.1 APPLICATION

A. Transformers, Unit Substations, and Uninterruptible Power Supplies (UPS):

1. Transformers, Unit Substations, and UPS devices within the building construction shall follow the following table:

Transformers	Base Type	Isolator Type	Static Defl (in.)	Mason Industries Type
Suspended – 45 to 350 kVA	Trapeze	Spring	1	30N
Suspended – Less than 45 kVA		Neoprene	0.05	W

2. Electrical connections to isolated transformers and UPS devices shall be made using flexible electrical connections Type A or Type B.

B. Mechanical Equipment:

1. Electrical connections to vibration isolated mechanical equipment shall be made using flexible electrical connections Type A or Type C.

3.2 INSTALLATION

A. General:

1. In all cases, isolated electrical equipment shall be positioned so that it is free standing and does not come in rigid contact with the building structure or other systems.

B. Isolation Mounts:

1. All mounts shall be aligned squarely above or below mounting points for the supported equipment.
2. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.
3. Hanger rods for vibration isolated supports shall be connected to structural beams or joists, not to the floor slab between beams and joists. Provide suitable intermediate support members as necessary.
4. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360° about the rod axis without contacting any object.

C. Flexible Electrical Connections:

1. Type C connections shall be installed in a grossly slack “U” shape or a 360 loop.
2. Rigid conduit on the isolated-equipment side of the flexible connection, and the flexible connection itself, shall not be tied to the building construction or other rigid structures.

3.3 SEISMIC REQUIREMENTS

A. Brace all electrical systems and items of equipment to withstand lateral and vertical forces that result from earthquakes. Refer to Part 1 of this section.

B. Provide slack cable restraints and bracing for conduit and cable trays as follows:

1. Conduit 2-1/2” in Diameter and Larger: Shall be braced per IBC.
2. Conduit Smaller than 2-1/2” in Diameter: Comply with IBC requirements, including flexible connections between component and the conduit.
3. Cable Trays with Weights Greater than 10 lbs/ft: Shall be braced per IBC.

C. All electrical equipment and systems shall be provided with restraints and anchors adequate to withstand the applicable force factors per the International Building Code.

D. Anchors and Equipment:

1. Calculations: Calculations shall be certified by a Structural Engineer registered in the State of Colorado with experience in the design of seismic restraints.

- E. For conduits crossing seismic separations, provide approved fittings that permit horizontal expansion and vertical and angular deflection. Selection of fitting to be based on the dimension of the separation and conduit size.

3.4 SEISMIC REQUIREMENTS FOR LIGHTING FIXTURES

- A. Pendant Light Fixtures: Provide approved seismic fixture suspension allowing for 45° swing in all directions without impacting adjacent obstruction or structure. For stem-mounted fixtures, provide approved seismic ball aligners at fixture and outlet box, and 9-gauge steel wire in each stem and with the circuit conductors, continuous from the fixture housing, through the outlet box, and attach directly to the structure above. Do not use ceiling construction to directly support the fixture. Within the fixture housing, provide a mechanically crimped cable loop and secure to the housing with a closed eyebolt nut and lockwasher. At the structure above, provide a cable loop and closed eye threaded lag screws and steel wedge drilled anchors. Level and adjust fixtures and remove cable slack before attaching to the fixture housing.
 - 1. Where pendant fixtures are indicated to be cable supported, provide 3/32" (minimum) stainless-steel aircraft cables, cable to rod swivel adapters, 1/4–20 rod extensions above the ceiling to the structure. Brace the rod seismically with a rod fitting and (3) 12-gauge steel wires extended from the rod to the structure at 120° angles.
 - 2. If a 45° swing cannot be achieved, brace fixtures to prevent contact with the adjacent obstruction or structure. All fixture suspension assemblies to be State of Colorado approved.
 - 3. Submit a sample of the seismic ball aligner and details of the cable attachments and assemblies with the fixture shop drawing submittal.
- B. Fixtures Installed In or On a Suspended Acoustical Ceiling System:
 - 1. As a minimum, all lighting fixtures shall be positively attached to the suspended ceiling system. The attachment device shall have a capacity of 100% of the lighting fixture weight acting in all directions.
 - 2. In addition to the ceiling system support methods required by code, because the ceiling system is supporting light fixtures, provide (2) 12-gauge steel hanger wires from diagonal corners of the fixture housing to the structure above for fixtures weighing less than 56 pounds.
 - 3. Lighting fixtures weighing 56 pounds or more shall be supported directly from the structure above by approved hangers. Do not use the ceiling suspension system to directly support the fixture.
 - 4. Pendant hung lighting fixtures shall be supported directly from the structure above with 9-gauge steel wire, or an approved equivalent. Do not use the ceiling suspension system to directly support the fixture.
 - 5. Attach surface-mounted fixtures to main runners with a minimum of two approved clamping devices, 14-gauge minimum, and support each clamp from the ceiling structure with 10-gauge wire.

END OF SECTION 26 05 48

SECTION 26 05 53 - IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this Section:
 - 1. “Electrical Requirements.”

1.2 SUMMARY

- A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:
 - 1. Buried electrical line warnings.
 - 2. Identification labeling for raceways, cables, and conductors.
 - 3. Operational instruction signs.
 - 4. Warning and caution signs.
 - 5. Equipment labels and signs.
- B. Related Sections: The following Sections contain requirements that relate to this Section;
 - 1. Division 9 Section “Painting” for related identification requirements.
 - 2. Division 26 Section “Electrical Power Conductors Cables” for requirements for color coding of conductors for phase identification.
- C. Refer to other Division 26 Sections for additional specific electrical identification associated with specific items.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified.
- C. Schedule of identification nomenclature to be used for identification signs and labels.

- D. Samples of engraved, plastic laminate to be used on switchgear, switchboards, disconnect switches and panelboards.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 “National Electrical Code.”
- B. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, “Scheme for the identification of Piping Systems,” with regard to type and size of lettering for raceway and cable labels.

PART 2 - PRODUCTS

2.1 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mil thick by 1 inch to 2 inches in width.
- B. Underground Line Marking Tape: Permanent, bright-colored, continuous-printed, plastic tape with magnetic tracer strip not less than 6-inches wide by 4-mil thick. Printed legend indicative of general type of underground line below.
- C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wrap around, cable/conductor markers with preprinted numbers and letters.
- D. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for sign up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in black letters on white face for normal power and white letters on red face for emergency and standby power. Plastic laminate shall be punched for mechanical fasteners. Refer to details on drawings for exact information requirements.
- E. Baked-Enamel Warning and Caution Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.
- F. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, non-fading, preprinted cellulose acetate butyrate signs with 20-gage, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide 1/4-inch grommets in corners for mounting.
- G. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or number 10/32 stainless-steel machine screws with nuts and flat and lock washers.

- H. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F. Provide ties in specified colors when used for color coding.
- I. Electronic Labels: Self-adhesive, 3/16-inch-industrial label, black on clear for normal circuits and red on clear for emergency/standby circuits. Acceptable manufacturers include the following:
 - 1. Brother
 - 2. Kroy

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.
- B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

3.2 IDENTIFICATION

- A. Identify Junction, Pull, and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indicating system voltage in black, preprinted on orange background. Install on outside of box cover. Also, label box covers with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels at concealed boxes.
- B. Underground Electrical Line Identification: During trench backfilling, for underground power, signal, and communications lines, install continuous underground plastic line marker, located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width of 16 inches; install a single line marker.
- C. Install line marker for underground wiring, both direct-buried and in raceway.
- D. Identify Raceways of Certain Systems with Color Banding: Band exposed or accessible raceways of the following systems for identification. Bands shall be painted with colors indicated below. Make each color band 2 inches-wide, completely encircling conduit, and place

adjacent bands of two-color markings in contact, side by side. Install bands at changes in direction, at penetrations of walls and floors, and at 40-foot maximum intervals in straight runs. Apply the following colors:

1. Fire Alarm Systems: Red.
 2. Fire Suppression Supervisory and Control System: Red and Yellow.
 3. Mechanical and Electrical Supervisory System: Green and Blue.
 4. Telephone System: Green and Yellow
 5. Tag or label conductors as follows:
 - a. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicating source and intent.
 - b. Multiple Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure label each conductor or cable. Provide label on each box indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by mean of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
 - c. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facilities' electrical installations.
- E. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- F. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the project secondary electrical system as follows:
- | <u>208/120-Volts</u> | <u>Phase</u> | <u>480/277-Volts</u> |
|----------------------|--------------|----------------------|
| Black | A | Brown |
| Red | B | Orange |
| Blue | C | Yellow |
| White | Neutral | Gray |
| Green | Ground | Green |
- G. Use conductors with color factory-applied the entire length of the conductors except as follows:
1. The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG:
 - a. Apply colored, pressure-sensitive plastic tap in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification

markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

- b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.
2. All grounded conductors No. 6 AWG and smaller shall be a factory applied color across the entire length of conductors.

H. Power Circuit Identification:

1. Securely fasten wrap-around marker bands to cables, feeders, and power circuits in pull boxes, junction boxes, and switchgear rooms.

I. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution, or instruction signs where required by NEC where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
3. Arc Flash Labels: All electrical equipment shall be marked with a label consisting of the following information:
 - a. Nominal voltage.
 - b. Available fault current at the equipment.
 - c. Clearing time.
 - d. Arc flash hazard boundary.
 - e. Flash hazard at 18”.
 - f. PPE (Personnel protective equipment) level.
 - g. Distance of limited approach.
 - h. Distance of restricted approach.
 - i. Distance of prohibited approach.
 - j. Date label is applied or calculations were performed.

J. Install equipment/system circuit/device identification as follows:

1. Apply equipment identification labels of engraved plastic-laminate on each major unit for electrical equipment. This includes communication/signal/alarm system, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 3/8-inch-high lettering on 1-1/2-inch-high label (2-inch-high where two lines are required), black lettering in white field for normal power and red lettering on white field for emergency and standby power. Text shall match

terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment:

- a. Panelboards, electrical cabinets, and enclosures.
 - 1) Labels shall include at a minimum: voltage, phase, ampacity, AIC rating, available fault current (and when it was calculated) and where the equipment is fed from. **Refer to detail on drawings for additional information.**
 - b. Access doors and panels for concealed electrical items.
 - c. Electrical switchgear and switchboards.
 - 1) Labels shall include at a minimum: voltage, phase, ampacity, AIC rating, available fault current and where the equipment is fed from. **Refer to detail on drawings for additional information.**
 - d. Motor starters, motor control centers.
 - e. Pushbutton stations.
 - f. Power transfer equipment.
 - g. Contactors.
 - h. Remote-controlled switches.
 - i. Dimmers.
 - j. Control devices.
 - k. Transformers.
 - 1) Include on label, location of primary overcurrent protection device.
 - l. Power generating units.
 - m. Telephone switching equipment.
 - n. Fire alarm master station or control panel.
 - o. Lighting control panel.
 - p. Static uninterruptable power supply
- 2. Apply electronic label on the outside of all receptacle and switch plates in all back of house spaces. Label shall be on the inside of the cover plate where exposed to the public. The labels shall identify circuit and panelboard.
 - 3. All emergency circuits shall be permanently marked as emergency as indicated below:
 - a. Junction Boxes – with permanently fastened labels.
 - b. Raceways – with permanently fastened labels at intervals of not more than 25ft.
- K. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification (including room numbers) of items controlled by each individual breaker.

- L. Fire Pump Service Identification: A placard shall be externally installed on the Fire Pump primary disconnecting means stating, "Fire Pump Disconnecting Mean." The lettering shall be at least one inch in height. In addition, a placard shall be placed adjacent to the Fire Pump controller stating the location of this disconnecting means and the location of the key (if the disconnecting means is locked).
- M. Electrical Service Room Distribution Placard: In each of the main electrical rooms, provide a single line riser diagram placard of the entire electrical distribution fed from that room. The placard shall also identify where other services are located per NEC 230.2(e). The riser diagram shall be framed under glass and mounted on the wall in the electrical room. The print shall be of diffusion transfer process to eliminate fading.

END OF SECTION 26 05 53

SECTION 26 09 43 - LIGHTING CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections apply to work of this section.
- B. Requirements of the following Division 26 Sections apply to this section:
 - 1. Basic Materials and Methods
 - 2. Lighting Fixtures
- C. Refer to lighting control drawings for operational intent of the following:
 - 1. Lighting control matrix on drawings for operational intent and device requirement.
 - 2. Typical control diagrams and details.
 - 3. Equipment layout and quantity.

1.2 SUMMARY

- A. Provide a complete and coordinated network lighting control system with distributed nodes as well as stand-alone room control system.
- B. The drawings and specifications indicate control intent for building areas. Where control intent is indicated either on drawings or specifications for a building area, the contractor shall provide that control feature to the entire area, as applicable.
- C. The exact quantity of product required (sensors, photocells, power packs, dimmer switches, relay panels, etc.) to meet the control intent, shall be determined by the manufacturer based upon the specific performance of the product. Where a revised quantity of product is required, the contractor shall furnish and install in coordination with the engineer and architect.
- D. Types of lighting control equipment specified in this section includes but is not limited to the following:
 - 1. Programmable relay panels
 - 2. Touch screen control stations
 - 3. I/O Modules
 - 4. Power packs
 - 5. Occupancy Sensors
 - 6. Photo Sensors
 - 7. Wall Controllers

8. Relay Control Panels
 9. Distributed Room Controllers
 10. UL924 Rated Devices
 11. System Communications Wiring
 12. Lighting Control Software
 13. A customized software which calendar based (365 days) to provide building wide automatic/remote and manual lighting control for interior and exterior light fixtures.
 14. Custom graphic control of plaza and ice rink lighting.
- E. Refer to other Division 26 sections for wires/cables, raceways, electrical boxes and fittings, and wiring devices which are required in conjunction with lighting control equipment to perform work of this section.
- F. The following outlines the areas of work to be controlled by this section.
1. General Lighting System Control
 - a. Interior Lighting: All corridors, restrooms, offices, storage rooms, laundry rooms, kitchens, etc.
 - b. Exterior Lighting: All pedestrian light poles, façade lighting, parking lot lighting, etc.
 - c. Dimming: All lobbies, conference rooms, dining areas, etc. shall be fully coordinated with the luminaire driver type for compatibility.
 - d. Advertising, graphic panels and wayfinding signage.
 - e. Local controls: Where denoted on drawings, local switching, dimming, and occupancy sensors shall be furnished and installed as shown on the drawings, as required by local energy codes, and operate independently of the lighting control system.
 - f. Daylight controls: all photocell control shall be seen as inputs to the lighting control system.

1.3 SUBMITTALS

Submittal documentation shall be furnished by the manufacturer for approval by the Engineer and must be approved in writing prior to shipment of any equipment from the manufacturer. Separate shop drawings shall be issued for different buildings covered in this scope. Each shall consist of:

- A. Product Data: The manufacturer shall submit in a bill of material form an itemized list of all materials being supplied to meet the specifications.
- B. Shop Drawings: Manufacturer shall submit plan drawings of all equipment/components, one-line diagram, relay/dimmer panel schedules, override dimmer/switch station schedules, and plan drawings with all device locations, including photocells, occupancy sensors, switch packs, I/O modules, override dimmer/switch locations, and panel locations. Sensor coverage and quantity shall be provided as part of shop drawings.

- C. Riser Diagram: Manufacturer shall submit a line diagram of the system configurations in sufficient detail to show the relative placement of all equipment and interconnection with equipment supplied by other manufacturers.
- D. Wiring Diagrams: Manufacturer shall submit typical wiring diagrams for all components. Detailed interconnection diagrams are required only if proper interwiring of components is not clearly indicated on typical wiring diagrams.
- E. Plan Drawings: Manufacturer shall submit hard copy color plan drawings showing the type and location of system components including photocells, occupancy sensors, switch packs, I/O Modules, etc. Sensor coverage and quantity shall be verified prior to the preparation of these drawings.
- F. Product Overview: Manufacturer shall submit data sheets on all components of the system. These shall describe all hardware and software items provided. A detailed line by line specification compliance shall also be included. The software shall identify the process for programming repeating time schedules.
- G. Driver/Lamp Coordination: The contractor shall submit to the manufacturer a complete matrix of all fixture drivers being controlled on the project and their associated control requirement. The manufacturer shall review this list for compatibility with their system components, approve, and provide this matrix in the submittal.
- H. Copies: Manufacturer shall provide the quantity of submittals as required by Division 1, "Submittals".
- I. Graphics Screens: Manufacturer shall submit graphic screen layouts as part of a two-step approval process.
 - 1. Contractor shall obtain and provide the manufacturer with current CAD drawings / reflected ceiling plans within 90 days of contract award for development of the graphic screens.
 - 2. Contractor shall obtain and provide the manufacturer with the latest electronic CAD or Revit files for use in creating colored lighting control zone drawings. Colored lighting control concept drawings are available from the design team.
 - 3. Initial Graphics Submittal: Manufacturer shall submit initial graphic screen layouts based on the requirements of this project a minimum of six months prior to substantial completion. Sample graphic screens from other projects are not acceptable.
 - 4. Final Graphics Submittal: Manufacturer shall submit final graphic screen layouts a minimum of 60 days prior to substantial completion.
- J. Maintenance Manuals: Furnish maintenance manuals which contain equipment cuts, operating instructions, troubleshooting procedures, and spare parts list for equipment. Ensure manual includes operating instructions in addition to instructions for maintenance of the system's software package.

- K. Service and Support Requirements: Provide the following for owner support and maintenance purposes after project completion and turnover.
1. Phone Support: Toll free technical support shall be available.
 2. Remote Support: The bidder shall offer a remote support capability.
 3. Onsite Support: The bidder shall offer onsite support that is billable at whole day rates.
 4. Service Contract: The bidder shall offer a Service Contract that packages phone, remote, and onsite support calls for the project. Response times for each type of support call shall be indicated in the terms of the service contract included in the bid package.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: The manufacturer shall provide a complete energy saving lighting control system capable of functioning and performing as required by these specifications and the plan drawings. It is the sole responsibility of the Electrical Contractor to ensure that all equipment meets the specifications.
- B. Approved manufacturers: n-light, Lutron, Crestron, or approved equal.
- C. Sensors shall be of the same or directly compatible manufacturer as the lighting control system.
- D. Installer's Qualifications: The lighting control manufacturing firm shall have a minimum of 5 years of successful installation experience on projects with lighting control equipment work similar to that required for this project.
- E. Codes and Standards:
1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC as applicable to construction, installation of lighting control equipment.
 2. UL Compliance: Comply with applicable requirements of UL standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors". Provide lighting control equipment and components which are UL-listed and labeled. Any custom cabinets that may be required shall be assembled by a U.L. listed panel shop that is approved for building industrial panels. Each panel shall bear a U.L. label detailing all requirements for industrial panel fabrication.
 3. NEMA Compliance: Comply with applicable requirements of NEMA's Standard Pub No. 250, "Enclosures for Electrical Equipment (1000-Volts Maximum)".
 4. All lighting control equipment shall be in compliance with FCC Emission Standards specified in Part 15 Subpart J for Class A applications.

1.5 WARRANTY

- A. Installation Warranty: A written warranty shall be supplied by the installing contractor agreeing to provide the labor and materials to replace any portion of the lighting control system

equipment or wiring that fails due to materials or workmanship for a period of twelve months after substantial completion.

- B. Manufacturer's Warranty: A written warranty shall be supplied by the manufacturer agreeing to replace any equipment that fails due to materials or workmanship for a period of 5 years.
- C. Warranty Commencement: Warranty shall begin at the point of substantial completion of the system, which is defined as the date when commissioning and owner training has been completed and the Owner obtains beneficial use of the system.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver lighting control equipment and components in factory-fabricated type containers or wrappings, which properly protect equipment from damage.
- B. Store lighting control equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.
- C. Handle lighting control equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

- A. System Architecture: The system shall utilize an independent lighting low-voltage communications network to communicate between system components (server, system processors, modules, wall switches, etc.). System shall operate independently of building data network infrastructure and shall not rely on owner or tenant supplied equipment for operation.
- B. Network Components: The manufacturer shall provide all network components (routers, switches, gateways, repeaters, etc.) as required to provide a complete distributed network. Network components such as servers, network processors, and network switches shall be provided within wall-mountable enclosures. Where rack-mounted components are provided by the manufacturer, the contractor shall provide wall-mounted network cabinets to house components. The contractor shall coordinate locations of these components within electrical rooms. Each cabinet shall be provided with a rack-mounted PDU with power conditioning to provide power to the network components.
- C. Lighting Control Server: Manufacturer shall provide a server to operate the lighting control software. This server shall be integrated into the lighting control equipment cabinets or shall be a rack-mountable server. The server shall be accessed via a remote terminal or web interface.

- D. Lighting Control Software: The System shall offer two, separate levels of PC interface: (1) personal lighting control for the average building occupant to control and adjust basic lighting functions in their workspace, and (2) central energy control for the lighting administrator to perform energy management, configuration maintenance, monitoring operations, and providing support to building occupants.
1. GUI: Shall provide a Windows graphical user interface.
 2. Central Control: Energy Control Software interface shall provide current status and enable configuration of all System zones including selected individual module availability, current light level, maximum light level, on/off status, occupancy status and emergency mode status.
 3. Reports: Energy performance reports shall be printable in a printer friendly format and downloadable for use in spreadsheet applications, etc.
 4. Personal Lighting Controls: The Personal Control Software interface shall provide current status and enable each user with the ability to dim and brighten lights, and turn them on and off by module. The Software shall offer user configurable light scenes, which may be programmed and then selected via the Software. Personal lighting control shall be available in open office environments.
- E. Dimmers and preset dimming lighting controls shall operate the following sources/load types with a smooth continuous Square Law dimming curve. Dimmers shall also be capable of operating these sources on a non-dim basis. Dimmers shall be electronically assigned to the appropriate load type/dimming curve and can be reassigned at any time. Universal-type dimmers that do not adjust the dimming curve shall not be acceptable.
1. LED Drivers: Drivers and control modules shall be fully compatible and tested to ensure intended working operation.
 - a. 0-10V Dimming shall provide dimming to specified level as listed on drawings.
 - b. Phase Dimming including leading edge (forward phase), and trailing edge (reverse phase).
 2. Magnetic Low-Voltage Transformer
 - a. Dimmer shall contain circuitry specifically designed to control and provide a symmetrical AC waveform to the input of magnetic low-voltage transformers.
 - b. Dimmer shall not cause a magnetic low-voltage transformer to operate above the transformer's rated operating current and temperature.
 - c. Dimmer shall contain circuitry to control dioded lamps.
 3. Electronic Low-Voltage Transformer
 - a. No flicker or interaction shall occur at any point in the dimming range.
 - b. For integral dimming, an interface shall be required.
 4. Non-Dim/Switched Loads

- F. Non-dim shall be rated to 16A of resistive, tungsten, induction, or capacitive loads. Non-dim shall incorporate an air gap relay to open circuit when load is off.
- G. Daylight Harvesting (Light Regulation Averaging): In a photo sensor-equipped System, the system processors shall rationalize changes to light levels when ambient (natural) light is available and shall maintain a steady light level when subjected to fluctuating ambient conditions. System shall utilize light level inputs from common and/or remote sensor locations to minimize the number of photo sensors required. The System shall operate with multiple users in harmony and not react adversely to manual override inputs. Daylight harvesting shall not impede personal lighting control and the ability to adjust light levels on a per fixture basis.
- H. Time Clock Scheduling: The System shall be programmable for scheduling lights on or off via the Energy Control Software interface.
 - 1. Override: Manual adjustments and occupancy sensor detection shall temporarily override off status imposed by time clock schedule.
 - 2. Response to Power Failure: In the event of a power failure, the time clock shall execute schedules that would still be in progress had they begun during the power outage.
 - 3. Flick warning: Each load shall be programmable to provide a warning five minutes prior to a scheduled lights-off event or expiry of a temporary override, the System shall provide two short light level drops as a warning to the affected occupants.
- I. BAC Net Communications Interface: Manufacturer shall provide the capability for communications with a BAC Net network. Contractor shall coordinate with the mechanical controls contractor to provide a complete interface to the BAC Net.
- J. Load Shed Mode: An automatic load shedding mode shall be available where, when activated through the System, the control unit will reduce its output to a programmable maximum electrical demand load. The System shall not shed more load than required and load shedding priority shall be centrally configurable by light fixture. The individual user shall retain the ability to override System light levels.
- K. Emergency Mode: There shall be a mode, when activated through the System, that will immediately adjust lights to full light output and retain that level until the mode is deactivated. This setting shall override all other inputs. The System shall interface with the building emergency monitoring system at a convenient point and not require multiple connections.
- L. Addressing: I/O Modules shall be centrally addressable, through the Lighting Control Software. To simplify installation and maintenance, the System shall not require manual recording of addresses for commissioning or reconfiguration.
- M. Programmable Task Tuning: Maximum light level programmability shall be available by individual module.
- N. Unoccupied State: The System shall provide two states when occupancy status is vacant as per an occupancy sensor: lights turn off or lights adjust to configurable light level.

- O. Occupied State: The System shall not isolate occupants by turning off lights that are still required for convenience and safety, such as a hallway path to exit the premises.
- P. Firewall Security: System firewall technology shall maintain network security.
- Q. Low-Voltage Wiring: Wiring shall be topology independent and not require splicing or termination. Prefabricated, quick connecting wiring shall be utilized. The maximum connected length of wiring shall be no less than 425 meters (1,400 feet) per channel.
- R. Reconfigurability: The assignment of individual fixtures to zones shall be centrally configurable by Energy Control Software such that physical rewiring will not be necessary when workspace reconfiguration is performed. Removal of covers, faceplates, ceiling tiles, etc. shall not be required.

2.2 PANEL HARDWARE

Provide the quantity of factory assembled and tested panels to control the zones indicated on the drawings. Each panel shall consist of:

- A. Lighting Control Relay Panels:
 - 1. General
 - a. Addressing: All lighting control panels shall be individually addressable via Energy Control Software.
 - b. Communication: All lighting control panels shall communicate via the same prefabricated, quick connecting low-voltage wiring as all other devices.
 - c. Wiring: Relay control panels shall be interconnected with any other devices on the same wiring loop.
 - d. Control panels shall have a minimum of 24 relays.
 - 2. Mechanical:
 - a. Backbox: It shall be shipped separate from the remainder of the equipment to allow for rough in of all conduits. It shall be made of code-gauge steel and contain no knockouts. Labels shall indicate the areas restricted to low-voltage wiring.
 - b. Chassis: It shall be pre-assembled and contain all relays, electronic and the power supply. The sheet metal chassis shall divide the panel into line voltage and low-voltage compartments.
 - c. Trim: A surface-mounted trim shall be provided that is painted the manufacturer's standard color. The trim shall contain a window for viewing the status LED's inside the panel. It shall contain a hinged, lockable door that, when open, gives access only to the low-voltage portion of the panel, including the relay manual overrides. A directory card shall be attached to the rear of the door. All doors shall be keyed alike.

- d. Provide a multi-voltage power supply transformer that shall provide all power for the panel. A secondary On/Off switch shall be provided to disconnect the control power from the panel for maintenance purposes. Provide internal overcurrent protection.
 - e. Relays: Each controlled circuit shall be connected through a single pole, single throw mechanically latching relay. A minimum of 48 relays shall be provided for each panel indicated on drawings. If more relays are required, provide additional 48 relay panels to accommodate the loads plus 20% spare.
 - 1) The relay shall contain a single solenoid coil that toggles the contacts to the opposite position with each operation.
 - 2) The relay shall have an actuator device to allow manual actuation of the contacts. Manual actuation shall function both with and without control power present at the relay.
 - 3) The relay shall provide a mechanical means of visual indication of the contact position.
 - 4) The main contacts shall be rated: 20A, 125 VAC Tungsten; 20A, 277 Ballast, 1.0 HP, 125 VAC: 1.5 HP, 250 VAC.
 - 5) Relays shall have a minimum short circuit current rating (SCCR) of 14,000 amps.
 - 6) Dual line and load terminals shall be provided for power wiring that will accept #10 - 14# AWG wires
 - 7) Auxiliary contacts shall be provided for pilot lights and feedback.
 - 8) Mechanical action shall be suitable for zero cross control.
 - 9) Control wires shall terminate in a modular connector that attaches to the chassis electronics.
3. Control Capabilities:
- a. Positive Load Feedback: The system shall continuously monitor the position of all loads to provide position indication. It shall alarm all unexpected changes of status and command failures.
 - b. Selectable Switch Inputs: Each switch input shall be user definable as one of 7 modes.
 - 1) Maintained Input: The load is turned on when it closes, and turned off when it opens.
 - 2) Momentary Input: The load toggles to the opposite state with each closure. No action is taken on opening.
 - 3) Time Delay: The load turns on when the switch closes and remains on for the pre-programmed period of time, after which it automatically turns off.
 - 4) Pulse Accumulator: When connected to an energy meter containing output pulse contacts, this input records the number of pulses received, corresponding to the amount of energy used.
 - 5) External: This input is broadcast over the network. It allows loads in this panel and anywhere in the network to respond to a switch input.

- 6) Alarm: This input is a momentary input that causes an alarm to be raised at the operator's station and adds an entry into the alarm log each time it is operated.
 - 7) Interlock: This input is used for cleaning crews. It will turn on its associated load. When the next interlocked load is activated, the previous one is turned off. Interlocked loads shall not cancel a time schedule or occupant override.
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- c. Memory Loss Protection: Programs loaded to automation cards shall be maintained in non-volatile memory, not subject to power outages.
 - d. Power Fail Recovery: The micro-processor shall operate whenever incoming power is with rated voltage tolerance. When incoming power fails, the micro-processor shall automatically halt program execution in a safe manner. Upon return of power, the micro-processor shall automatically reboot and return the system to normal operation. Any time schedule events that should have occurred during the power outage shall be automatically updated.
 - e. Real Time Clock: A digital clock shall be provided time of day, day of week and date. Automatic leap year adjustment and selectable daylight savings time adjustments shall be provided.
 - f. Astronomical Clock: The clock shall automatically calculate sunrise and sunset based on the date and geographic location. Selectable offset of 0 to 120 minutes before and after either sunrise or sunset shall be programmable.
 - g. Time Scheduling: Schedule capacity shall be large enough to allow the user to program a complete year of events with exact on/off times for relays. In addition, each of the up to 48 loads in each panel shall be able to be uniquely programming with any combination of up to 12 "On" or "Off" events per day. The scheduler shall utilize a 12 month calendar in which repeating schedules for events can be easily redefined in the calendar-based scheduling software.
 - h. Programmable Matrixing. All switch inputs shall be programmable to control any load or combination of loads even if they exist in different switch groups (group overlapping). Any switch input shall be able to control loads anywhere in the network. All programming changes shall be made via programming. No rewiring or switches shall be required to accomplish these functions.
 - i. Occupant Warning. Each load shall be programmable to provide a warning blink prior to each scheduled "Off" time. Once the warning has occurred, the occupant may cancel the upcoming "Off" command by operating a local override switch. The load shall remain "On" until expiration of the time out period, or another "Off" command is received. Occupant warning time shall be adjustable between 5 and 30 minutes.
 - j. Load Sequencing. Multiple loads shall not operate simultaneously, even when triggered by the same switch input or time schedule. Each load operation shall be staggered to reduce the inrush effects on the power system. Sequencing choices shall be 1, 5, 10, 15, 20, 30 or 60 loads per second.
 - k. Load Priority. To avoid unnecessary confusion to the users, the system shall use a "last action" priority scheme. Time schedules and switch input overrides shall each cancel the action of each other. Momentary and maintained switches operating on the same load shall also cancel each other's actions.

B. Dimming Panels

1. Mechanical:

- a. Panel shall be wall or floor mounted NEMA grade, constructed of sheet steel plates not less than #16 U.S gauge. Contractor shall reinforce wall as required for wall-mounted panels.
- b. Panel shall be completely pre-wired by the manufacturer. The contractor shall be required to provide input feed wiring, load wiring, and control wiring. No other wiring or assembly by the contractor shall be permitted.
- c. Unless otherwise indicated, panels shall contain branch circuit protection for each dimming module. Branch circuit breakers shall have the following performance characteristics:
 - 1) Be U.L. listed under U.L. 489 as molded case circuit breaker for use on lighting circuits.
 - 2) Contain a visual trip indicator and shall be rated at 10,000 AIC (120V) or 14,000 AIC (277V), unless otherwise noted.
 - 3) Be thermal-magnetic in construction for both overload and dead short protection. The use of fully magnetic breakers shall not be acceptable, even when used in conjunction with individual dimmer thermal cutouts.
 - 4) Be switched duty (SWD) rated so that the loads can be switched off via the breaker.
- d. Panel shall be shipped with each dimmer in a BYPASS position via a jumper bar inserted between the input and load terminals. These jumpers shall carry the complete load current and shall be reusable at any time.
- e. Panels shall be cooled via free-convection, unaided by fans, and capable of continuous operation to all of these Specifications within an ambient temperature range of 0°C (32°F) to 40°C (104°F).
- f. Panel shall provide capability to electronically assign each circuit any zone in the dimming system. Panels using mechanical switches, rewiring, or EPROMS shall not be acceptable.
- g. Multiple panels shall be capable of operating in one system, up to a maximum of 32 panels and 768 dimmers. Panels shall have the ability to control individual circuits without controls.
- h. For panels fed with normal/emergency feeder, panel shall include electronics to bring all circuits to full on condition upon loss of normal power and subsequent presence of emergency power. Electronics shall switch both the intensity signal and the on/off signal of each dimmer connected to an emergency circuit between the local and a full-on constant drive supply. This type of emergency may be used with either a normal/emergency generator or a constant hot secondary utility feed where the emergency transfer occurs on the line side (upstream) of the dimming panel and requires only a single normal/emergency feeder.

- i. Panels shall have the following additional characteristics:
 - 1) Be designed to prevent any foreign objects from coming into contact with any part of the panel which would be at an elevated temperature, such as the dimmer extrusions or heat fins.
 - 2) Be designed to provide airflow across the heat sink areas and through the dimmer chassis. Panel sections which provide airflow only across heat sinks shall not be mounted one above another in order to allow for adequate heat dissipation.

2. Dimming Modules

- a. One type of modular dimming card shall be used for all sources. Systems requiring different types of modules or modular dimming cards shall not be acceptable.
- b. A positive air gap relay shall be employed with each dimmer to ensure that the load circuits are open when the "off" function is selected at a control station. These relays need not be integral to the dimming module but must be integral to the dimming panel. Lighting control manufacturer shall provide necessary control interface(s) as part of the control system.
- c. All dimmers shall be voltage regulated so that a nominal change in the voltage shall not cause a perceptible change in output voltage.
- d. The silicon thyristors used to control the power furnished to the loads shall be both designed and tested to withstand surges, without impairment to performance, of 6000VA, 3000A (equivalent to near lightning strike) as specified by ANSI/IEEE Standard C62.41. Upon request, the manufacturer shall provide a means to demonstrate conformance to this specification using the appropriate surge-generation equipment.
- e. Under full-load conditions in a 40°C environment, all silicon thyristors shall operate at minimum 20°C safely margin below the component temperature rating.
- f. Filtering shall be provided in each circuit so that the current rise time shall be at least 400 µsec at 50% rated dimmer capacity as measured from 10-90% of the load current waveform at a 90° conduction angle, and at no point rise faster than 30mA/µsec. Manufacturers should note that additional filters may be required to meet this specification. These filters need not be integral to the dimming module, but must be integral to the dimming cabinet.
- g. Dimmer output voltage shall be a minimum 95% of input voltage at maximum intensity setting.
- h. Minimum and maximum light levels shall be user adjustable for each dimmer.

3. Integral Dimming

- a. Preset dimming controls shall be capable of operating at rated capacity without adversely affecting design lifetime.
- b. Preset dimming controls shall mount individually in standard 2, 3, or 4-gang U.S wall boxes.
- c. Preset dimming controls shall operate in an ambient temperature range of 0°C (32°F) to 40°C (104°F).

- d. Preset dimming controls shall incorporate an airgap switch, which shall be accessible without removing faceplate. The airgap switch shall be capable of meeting applicable requirements of UL 20 for airgap switches in incandescent dimmers.
- e. Preset dimming controls shall meet IEC 801-2, tested to withstand 15kV electrostatic discharge without damage or loss of memory.
- f. Preset dimming controls shall meet ANSI/IEEE Standard C62.41-1980, tested to withstand voltage surges of up to 6000V and current surges up to 200A without damage.
- g. Preset dimming controls shall meet the UL 20 limited short circuit test requirement for snap switches.
- h. Preset dimming controls shall be voltage regulated.
- i. Preset dimming controls shall utilize an LC filtering network to minimize interference with properly installed radio, audio, and video equipment.
- j. Minimum light levels shall be user adjustable in order to compensate for different sources and loading.
- k. Separate power booster/interface(s) shall increase dimmer capacity. Capacity shall range from 1000W/VA to 30,000W/VA. Quantities and size of each type of power booster shall be provided to control each type of load shown on the load schedule and/or the drawings.

C. Control Devices

- 1. Momentary Switches and Plates. Low-voltage override switches shall be provided where indicated on the plans.
 - a. Switches shall be an individual momentary push button per load group, providing toggle action, "On" only action or "Off" only action as required. Selection of action shall be program settable within the system and changeable at a later date if usage patterns change.
 - b. Switches shall be supplied with bi-colored LED pilot light for status. Provide red LED for off and green LED for on. Switch shall flash during the five minute sweep warning.
 - c. Up to six switches shall be mountable in a 2" deep single gang box. More switches shall be mountable in multiple gang boxes.
 - d. Metallic switchplates and style frames shall be provided. Color combination shall be approved by the Architect prior to fabrication.
 - e. Each zone button shall be labeled to clearly identify the zone being controlled.
- 2. Photo Controller. An exterior photo controller with exterior photocell shall be provided to control exterior zones.
 - a. An exterior weatherproof photocell shall be mounted on the roof facing a northerly direction, away from other artificial sources of light.
- 3. ACLR (Automatic Control Load Relay) Interface to allow control of emergency lighting. Device to comply with UL924 listing requirements.

4. BCELTS (Branch Circuit Emergency Light Transfer Switch). Interface to allow control of phased dimmed emergency lighting. Device to comply with UL1008 requirements
5. Wall Box Dimmers
 - a. All devices shall be UL listed specifically for the required loads (i.e., incandescent, fluorescent, low voltage, electronic low voltage). Manufacturer shall provide file card upon request. Universal dimmers shall not be acceptable.
 - b. Manufacturer shall maintain ISO 9001 certification. Provide a copy of the certificate as part of the submittal.
 - c. All dimmers and switches shall incorporate an air gap which shall be accessible without removing the faceplate. The air gap switch shall be capable of meeting all applicable requirements of UL 20 and UL 1472 for air gap switches in incandescent dimmers.
 - d. All dimmers and switches shall provide power failure memory. Should power be interrupted and subsequently returned, the lights will come back on to the same levels set prior to the power interruption. Restoration to some other default level is not acceptable.
 - e. Dimmers and switches shall meet ANSI/IEEE Standard C62.41-1980, tested to withstand voltage surges of up to 6000V and current surges of up to 200A without damage.
 - f. Dimmers and switches shall meet the UL 20 and UL 1472 limited short circuit test requirement for snap switches.
 - g. Dimmer control shall be linear slide. Dimmer shall provide a smooth and continuous Square Law dimming curve.
 - h. Dimmer shall be voltage regulated so that +10% variation in line voltage shall cause not more than a +5% variation in load voltage when dimmer is operating at 40V (5% light output).
 - i. Dimmers shall utilize a LC filtering network to minimize interference with properly installed radio, audio, and video equipment.
 - j. Dimmer control slider shall be captured.
 - k. Faceplate shall snap on to device with no visible means of attachment. Heat-fins shall not be visible on front of device. At locations with multiple devices, one seamless, multi-gang faceplate shall be provided. Contractor is responsible for coordination of proper back box size and faceplate type.
6. I/O Module (IOM)
 - a. General:
 - 1) I/O Module shall be the common interface to a driver, sensor, or power pack.
 - 2) Addressing: I/O Module shall be individually addressable via Energy Control Software.
 - 3) Response to Power Failure: In the event of a power failure, I/O Modules connected to light fixtures shall default to the "on" state at full light output.

b. Electrical Specifications

- 1) Ratings: Shall be low-voltage input.
- 2) Voltage Compatibility: Universal voltage control capability to 347 VAC maximum.
- 3) Primary Relay Rating: 347V, 0.8A/277V, 1A/240V, 1.2A/120V, 2.5A
- 4) Power: Shall supply 12 VDC @ 25 mA power to attached sensor.
- 5) Control Signal: Shall supply 0 to 10 VDC dimming signal to attached driver or receive control signals from attached sensor.
- 6) Memory: Retains all system settings in non-volatile memory.

c. Mechanical Specifications

- 1) Wiring: I/O Module shall not require wiring connections to the System apart from prefabricated, quick connecting low-voltage wiring.

d. Environmental Specifications

- 1) Operating Temperature Range: 0°C to +40°C
- 2) Relative Humidity: 20% to 90% non-condensing

7. Photo Sensors

a. Interior:

- 1) A sensor that measures ambient light in a finite area shall be available.
- 2) The sensor shall measure light from any source in the visible spectrum within at least a 60° cone. It shall measure light between 0 and minimum 75 foot-candles.
- 3) Electrical: Rating: Maximum 24VDC input voltage.
- 4) Mounting: The sensor shall be flush mounted on or recessed inside ceiling tile.

b. Exterior:

- 1) An exterior photo controller with exterior photocell shall be provided to control exterior circuits.
- 2) An exterior weatherproof photocell shall be mounted on the roof facing a northerly direction, but not into existing sources of light.
- 3) A low-voltage photo controller shall be mounted adjacent to one of the lighting control panels containing exterior circuits.

8. Occupancy Sensors

- a. Sensors using passive infrared, ultrasonic, acoustic, and multi-technology adaptive technology shall be available.
- b. Sensor timeouts shall be configurable by System software.

- c. Electrical Rating: Maximum 24 VDC input voltage.
- d. Mounting: Sensors for mounting on ceilings and walls, including corners, must be available.

9. Four Scene Preset Control

- a. Controls shall provide access to 4 preset lighting scenes and off for up to 8 control zones. Control shall be capable of storing an additional 12 preset lighting scenes. Scenes shall be changeable as required. Up to 8 controls may be tied together for more than 8 zones. Controls shall incorporate built-in wide-angle infrared receiver, providing control via a separate infrared wireless remote control transmitter from up to 50 feet away. Preset shall be set via easy-to-use raise/lower switches, one raise and lower switch per zone. The intensity for each zone shall be indicated via an illuminated bargraph Programming of preset scenes shall be accomplished without the use of an ENTER or STORE button. One or more zones may be temporarily overridden without altering the scene values which are stored in memory. Lighting levels shall fade smoothly between scenes at time intervals of 0-59 seconds or 1 to 60 minutes. The fade time shall be separately selectable for each scene. Additionally, control shall provide power failure memory for ten years.
- b. Manufacturer shall maintain ISO 9001 certification. Provide a copy of the certificate as part of the submittal.

10. Dimming Accessory Control Options

Provide the following controls for use with the preset control(s) as shown on the drawings and/or described in LIGHTING CONTROL DESCRIPTIONS:

- a. Two Scene Entrance Control(s) shall be capable of recalling Scene One plus Off, Scenes 7 and 8, or Scenes 13 and 14. Also can be used as raise/lower partition control and Lockout. All above based on dipswitch settings.
- b. Four Scene Control(s) shall be capable of recalling any one of four scenes, master raise/lower, and Off. Control shall provide access to up to 16 scenes.
- c. Fine Tuning Control(s) shall allow the temporary override of a particular zone or zones from the preset light level.
- d. Infrared Wireless Transmitter(s) shall be capable of recalling any one of four preset scenes and Off. In addition, a master raise/lower shall be provided. The transmitter shall be manufactured by the dimming system manufacturer. The range of the transmitter to any single receiver shall be at least 50 feet. Wall receiver shall incorporate buttons for four scene select, master raise/lower, and off. Ceiling receiver shall provide 360 degree view and an integral LED to provide feedback of proper infrared signal.
- e. Special Function Control(s) shall provide the following functions:
 - 1) Sequencing shall allow the user to set up and operate a sequence of 4, 12, or 60 steps. A sequence shall be defined as a series of steps, while a step shall be defined as the recall of a scene. Each step interval is adjustable from 1 second to 60 minutes.

- 2) Zone lockout shall allow temporary changes without altering light levels preset for each scene.
 - 3) Scene lockout shall lockout the control, maintaining current scene and disabling all buttons on the preset dimming controls.
 - 4) Fade override shall set all fade times to zero.
- f. Partition Control(s) shall provide two or four buttons for operating multiple preset units independently or in combination. Each button shall have a corresponding LED to indicate status of a specific partition "door."
- g. Photocell Interface Control(s) shall provide scene selection via daylight photosensor.
- h. Equipment Interface(s) shall allow access to preset dimming control(s) via one of the following methods:
- 1) Isolated momentary/maintained dry contact closures. Where indicated on the drawings, each interface shall provide isolated maintained contact closures rated at 200mA at 30VDC for pilot light status feedback.
 - 2) For use with four scene preset control, RS232 serial communication.
 - 3) For use with four scene preset control, astronomic time clock with 60 events/day and 4 schedules.
 - 4) For use with multiple area-centralized control, DMX512 interface with control of 32 continuous dimming zones via external DMX512 device.

2.3 NETWORK REQUIREMENTS

The lighting control system shall be a distributed intelligence system, consisting of multiple panels that operate on a network.

- A. This network shall allow up to 500 lighting control panel(s) to be networked by a shielded dataline control wire. The dataline shall be Belden type or as required by the manufacturer with maximum length of 7500 feet without the use of repeaters. The network shall be self-powered. No external power supply shall be allowed.
- B. Independent Operation. Network communications, time of day schedules, and input and load control shall reside in each panel. Each panel shall continue to function independently of other panels if a network failure occurs.
- C. Fire Alarm Interface. Provide connection from the fire alarm system to energize specific lighting control zones based on a fire alarm event.

2.4 LIGHTING CONTROL SOFTWARE

- A. The Lighting Control Computer (LCC) shall provide the ability to centrally program and monitor loads through application specific software and user-friendly, graphic oriented screens. It shall also provide backup for panelboard/panel data recovery. This computer shall allow

access to all base area lighting control systems that are associated with the scope of new construction and renovation at the base area. The Main LCC shall be located the Base Area Operator's Office or Command Center.

1. Computer / touch screen shall be password protected based on user access level.
 2. Computer shall be able to access all owner designated screens, programs, etc. Event lighting screens or overrides shall not be accessed from this location.
- B. The Lighting Control Touch Screen(s) (LCTS) shall provide the ability to centrally access and monitor loads through application specific software and user friendly, graphic oriented screens. Secondary LCC's shall be located in each building Promenade/Plaza, Building B (Gondola Square), KVC (Sheraton). Each screen shall allow direct access to the entire building lighting control system associated with the scope of this project.
1. Computer shall be password protected based on user access level.
 2. Computer shall allow keyboard / mouse operation.
- C. Lighting control manufacturer shall provide a software program (windows based) that provides for programming and monitoring of the lighting control system.
1. The software shall be complete with multiple windows, point and click operation, dialog boxes, menu bar, scroll bars, status bar, control buttons, and context sensitive help screens.
 2. The software shall be icon driven with each button corresponding to a major function of the lighting control system.
 3. Security codes shall be assignable so that different operators shall have different levels of access to the system. Different security levels shall be provided for monitoring, override, programming and administrator access to the system.
 4. Configuration dialog boxes shall be provided that allow assignment of descriptions to individual loads and inputs. These descriptions shall be carried over automatically to other screens.
 5. A time schedule editor shall be provided which allows a time schedule for multiple loads or repeating events to be viewed, copied, and edited on the same screen and shall be programmed into the 12 month calendar.
 6. A monitor and override screen shall be provided that shows each load in the system, its current status and the reason for the last change in operation. From this screen it shall be possible to manually turn loads On and Off.
 7. A grouping function shall be provided that allows assigning of a time schedule or switch input to multiple loads located anywhere in the system. Once defined schedules for all loads can be changed by simply changing the group schedule. The software shall automatically update the database in each lighting control panel.
- D. Event Control: The software shall be specifically custom designed to control lighting in multi-use facilities such as stadiums. Office building type software is unacceptable. The software shall be the product of the lighting control manufacturer and shall provide for customization to meet specific project requirements as specified herein.

- E. The manufacturer shall provide the latest version of software available at the time of final acceptance of the system by the owner. This provision shall be at no additional cost to the owner, provided the improved software is fully compatible with the system hardware as installed.
- F. Graphics Control Software (GCS). The software package shall be supplied that provides a graphical interface.
 - 1. The software shall operate with the other control software installed. It shall be object oriented with pull down menus and built in help screens. Provide 40 graphic screens.
 - 2. The operator shall be able to individually control any lighting load connected to the system. The operator shall be able to control the load by activating the graphic symbol representing the load or by activating control buttons.
 - 3. Load status shall be indicated by changing the color of the graphics symbol or control button. Green shall indicate the load is On; Gray shall indicate the load is Off.
 - 4. A 12 month calendar in which all games can be programmed for a full year.
- G. Graphic Screens. Anticipated graphic screens are as follows:
 - 1. Main Screen (Project Name, Graphics, etc.)
 - 2. Floor Plan Screens
 - a. Overall plan of each level. The main screen shall be provided that illustrates the overall building.
 - 1) When the cursor is moved to a portion of the building corresponding to a detail screen, the screen area shall become highlighted.
 - 2) Clicking the mouse while within the highlighted area shall automatically bring up the corresponding detail area screen.
 - 3) Movement between the main screen and subsequent screens shall also be possible by using control buttons.
 - 3. Overall zone control – including single button on/off control for entire buildings zones.
 - 4. Egress Lighting Control.
 - a. Provide override control for egress lighting. Access to the egress lighting zones shall be password protected.
 - b. Provide positive verification button which states: “You are about to turn off code required egress lights. Confirm that these areas are not occupied.”
 - 5. Exterior Control Zones
 - a. Site Lighting
 - b. Ice skating rink – Non Event Mode
 - c. Ice Skating rink – Event Mode
 - d. Façade Lighting
 - e. Site power

6. Event Lighting – Plan View

- a. Overall Site Plan
- b. Individual Quad/Area Plan
- c. Event Screen(s) – Ice skating, concert, maintenance, etc.

- H. The manufacturer shall provide the latest version of software available at the time of final acceptance of the system by the owner. This provision shall be at no additional cost to the owner, provided the improved software is fully compatible with the system hardware as installed.

2.5 TOUCH SCREENS

A. Hardware Configuration:

- 1. Touch screens shall be surface or flush mounted. Platform-mounted touch screens are not acceptable.
- 2. Provide lockable cover or access credentials for locations subject to public access.

B. Basis of Design: n-light 'UNITOUCH' or FRESCO
Features shall include:

- 1. LCD touch screen able to show building graphics.
- 2. Interface module for Ethernet connection.
- 3. Onscreen keyboard and mouse capability.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting Control Panel:

- 1. Install lighting control panels as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standards of Installation" and in compliance with recognized industry practices to ensure that products fulfill requirements.
- 2. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers' published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with torque tightening requirements specified in UL Standards 486A and B.
- 3. Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically anchored.

4. Provide engraved, plastic laminate labels for all lighting control panels indicating name, voltage, phase, wire and short circuit rating. Refer to Section 26 05 53 for more information.
5. Provide typed relay directory card upon completion of installation work to match as-built conditions and nomenclature indicated on engineering drawings and submit directories to the Engineer for review prior to mounting in panel.

B. Dimming Panel:

1. Wiring from dimming panel to preset dimming control and accessory controls shall be low voltage Class 2 wiring. All lighting control wiring shall be in an approved raceway specified in Section 26 05 33.
2. Provide accessories as required for construction type indicated on Finish Schedule. Lighting control catalog numbers do not necessarily denote specific mounting accessories for type of wall or surface in which a lighting control may be installed.
3. Provide adequate and sturdy support for each lighting control component. Contractor shall be responsible for verifying weight and mounting method of all lighting controls and furnishing and installing suitable supports. Lighting control mounting assemblies shall comply with all local codes and regulations.
4. Contractor shall be responsible for mounting the lighting controls at the proper depth, and for coordinating the cutout size and shape in wall to ensure that the faceplate covers the cutout entirely. Refer to drawings for location and mounting height of controls.
5. Install lighting controls with vent holes free of air-blocking obstacles.
6. Support elements shall not be mounted to or in contact with ducts or pipes.
7. Mask the lighting controls as necessary to protect the controls during construction.
8. At the completion of construction, clean the face plates and exposed surfaces of all lighting controls, so as to render them free of any material, substance or film foreign to the lighting control. Use soft, non-abrasive cloth and a cleaning solution recommended by the lighting control manufacturer. If the lighting controls are deemed dirty by the Architect at the completion of the project, the Contractor shall clean them at no additional cost to the Owner. Lighting control components whose finishes are damaged shall be replaced at no cost to the Owner.
9. Contractor shall furnish all equipment, labor and materials for the proper installation and system setup of all lighting controls and components as shown on drawings and as specified. System setup includes defining each dimmer's load type, assigning each load to a zone, and setting the control functions. System setup shall take place before building is turned over to Owner, after regular working hours where required.

C. Control Devices:

1. Install lighting control devices in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
2. Install occupancy sensors and daylight sensors in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that

products fulfill requirements. Confirm sensors provide coverage for the spaces in which they are installed and provide additional sensors as required for a completely functional system.

3.2 WIRING INSTALLATION

- A. Install wiring between control devices for hard wired connections. All lighting control wiring shall be in an approved raceway specified in Section 26 05 33.
- B. Coordinate with Division 26 for electrical work, including raceways, electrical boxes and fittings, as necessary to interface installation of lighting control equipment with other work. This Contractor shall route all raceways for lighting control circuits through the lighting control panel, furnish all line and load side conductors, and terminate the line and load side of the lighting control relays. This Contractor shall provide wiring for all remote lighting switches, devices, and their terminations as shown in the construction documents.
 - 1. If the available fault at the panel feeding the branch circuits exceeds the SCCR of the relay, route the branch circuit an additional ten feet between the panel and the lighting control panel.
- C. Provide all low-voltage terminations within the lighting control cabinets, to LCD remote control stations, and all required network cabling between lighting control panels.

3.3 GROUNDING

- A. Provide equipment grounding connections for lighting control equipment. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.4 CLEANING

- A. Cleaning: The contractor shall remove all paint spatters and other spots, dirt and debris from the equipment. Clean equipment and devices internally and externally using methods and materials recommended by the manufacturers.

3.5 COMMISSIONING

- A. Pre-functional Checklist: Contractor shall perform pre-functional checklist as required for the fundamental commissioning of the lighting control system.
- B. Operational Test: This contractor shall provide a complete set of “as wired” drawings of the lighting control system to the owner. These drawings shall be prepared and verified prior to

commissioning of the system. Any extra expenses incurred in commissioning the system due to inaccurate or incomplete wiring shall be borne by the electrical contractor.

1. Provide a factory technician to inspect the installation prior to energizing and starting up the lighting control system. This service shall be provided within fourteen days of written notification to the manufacturer that the installation is complete and ready for start-up.
 2. The graphic screens shall be functional a minimum of three weeks prior to substantial completion.
- C. Commissioning: The contractor shall arrange and pay for the services of factory trained representatives to commission the lighting control system. They shall verify that the contractor has properly installed and interconnected all supplied components. They shall start up all equipment and demonstrate that it meets the requirements of this specification.
- D. Programming: Arrange and pay for the services of factory authorized service technicians to install an initial lighting control program into the system.
1. Coordinate operational schedules with the Owner so that a complete schedule is available at the time of commissioning. This Contractor shall be responsible for schedule updates until system is turned over to Owner.
 2. Manufacturer shall install the graphics software onto the Lighting Control Computer (LCC) or a designated computer as determined by the owner.
- E. Reports: Prepare written reports of tests and observations. Report defective materials and unsatisfactory test results. Record repairs and adjustments made.

3.6 CUSTOMER SUPPORT SERVICES

- A. Training: As part of the commissioning procedures, the manufacturer shall train the owner's representatives in the operation of the system. The manufacturer shall attend all training sessions in person.
1. A minimum of 80 hours of on-site training shall be provided.
 2. Training shall occur in at least three separate visits. The first two visits shall occur at least 30 days prior to substantial completion. Another visit shall occur 30 days after the opening of the facility. Training shall include but not be limited to the following:
 - a. User group training for manual override locations, functions and sweeps.
 - b. Control interface.
 - c. Programming owner requested changes.
 3. The manufacturer shall attend and provide technical support for the first of each type of event – football, soccer, or concert.
- B. Technical Support: The manufacturer shall supply telephone support at no additional cost to the owner for the duration of the warranty period.

- C. Spare Components: The manufacturer shall provide the following spare parts to the owner.
1. A minimum of 10 spare relays.
 2. A minimum of 5 occupancy sensors.
 3. A minimum of 2 daylight sensors.
 4. A minimum of 2 spare panel communication cards.
 5. A minimum of 2 key pads.
- D. Replacement components: The manufacturer shall be able to ship replacement parts within 24 hours for any component that fails during the warranty period.
- E. Extended Service Coverage: Maintenance agreements shall be available from the manufacturer to provide service for the system both during and after the warranty period.

END OF SECTION 26 09 43

SECTION 26 22 13 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this section.
- B. Requirements of the following Division 26 Sections apply to this section.
 - 1. "Electrical Requirements."

1.2 SUMMARY

- A. This section includes general purpose and specialty dry type transformer with winding rated 600V or less, with capacities up to 1000 KVA.
- B. Related Sections: The following Division 26 Sections contain requirements that relate to this section:
 - 1. "Electrical Identification" for signs associated with transformer installations.
- C. All switchboards, panelboards, switchgears, transformers, disconnect switches, starters, etc., shall be fabricated by same manufacturer throughout the entire project unless specifically noted otherwise.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections:
 - 1. Product data for each transformer, including dimensional floor plans of electrical rooms, sections, and elevations showing minimum clearances, installed devices, and material lists.
 - 2. Transformer physical characteristics, including dimensions, weight, KVA rating, voltage, % impedance, taps, insulation class and sound levels.
 - 3. Wiring diagrams from manufacturer differentiating between manufacturer-installed and field-installed wiring.
 - 4. Transformer no-load losses and efficiency ratings.
 - 5. Product certificates, signed by manufacturer of transformers certifying that their products comply with the specified requirements.

6. Product Test Reports: Certified copies of manufacturer's design and routine factory tests required by the referenced standards.

1.4 PROJECT RECORD DOCUMENTS

- A. Maintain a redline set of contract documents noting all revisions and deviations that are made during the course of the project.
- B. Manufacturer shall provide copies of installation, Operation and Maintenance (O&M) procedures to owner in accordance with general requirements of Division 01 and Division 26.
- C. Submit O&M data based on factory and field testing, operations and maintenance of specified product.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: A firm member of NEMA who is regularly engaged in manufacturing components that comply with the requirements of these Specifications and that have been used on at least five projects of similar size and scope as this Project.
- B. Field Testing Organization Qualifications: To qualify for acceptance, an independent testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.

1.6 REFERENCES

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. ANSI/IEEE C57.96, Distribution and Power Transformers, Guide for Loading Dry-Type appendix to ANSI C57.12 standards.
- C. ANSI/IEEE C89.2 – Dry Type Transformers for General Application.
- D. IEEE C57.12.01, General Requirements for Dry-Type Distribution and Power Transformers including those with Solid Cast and/or Resin-Encapsulated Windings.
- E. IEEE C57.12.91, Test Code for Dry-Type Distribution and Power Transformers
- F. 2016 10 CFR Part 431 Energy Conservation Program: Energy Conservation Standards for Distribution Transformers
- G. NEMA ST 20, Dry-Type Transformers for General Applications.

- H. UL Listing and Labeling: Items provided under this section shall be listed and labeled by UL.
- I. Nationally Recognized Testing Laboratory Compliance (NRTL): Items provided under this section shall be NRTL listed and labeled. The term “NRTL” shall be as defined in OSHA Regulation 1910.7.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle transformer in accordance with the manufacture’s recommendations.
- B. Transformers shall be located in well-ventilated areas, free from excess humidity, dust, dirt hazardous materials. Transformer shall be protected to prevent moisture from entering enclosure.
- C. Transformer shall be shipped with edge and top protection that is adequate to protect the transformer enclosure from common dents and scratches.

1.8 WARRANTY

- A. Manufacturer warrants equipment to be free from defects in material and workmanship for 1 year from substantial completion.

PART 2 - PRODUCTS

2.1 GENERAL PURPOSE, DRY-TYPE DOE 2016 TRANSFORMER

- A. Comply with NEMA Standard ST 20 “Dry-Type” Transformers for General Applications.
- B. Transformers: Factory assembled and tested air-cooled units of types specified, having characteristics and ratings as indicated on drawings. Units shall be designed for ratings as indicated in drawings and for 60 Hz service.
- C. Cores: Core construction shall be of Grain oriented, non-aging silicon steel with high permeability, low hysteresis and low eddy current losses as need to achieve required efficiency levels. Core laminations shall be tightly assembled and magnetic flux densities shall be kept well below the saturation point.
- D. Coils: Continuous windings without splices except for taps.
- E. Internal Coil Connections: Brazed or pressure type.

- F. Provide high quality copper windings. Wiring compartment and termination shall be accessible by removing enclosure front panels. Three phase transformers shall use one coil per phase in primary and secondary windings.
- G. Transformers shall meet the energy efficiency requirements of 2016 10 CFR Part 431. The use of fans to obtain rated KVA or any published rating shall not be permitted for all transformer types.
- H. Efficiency at 35% nameplate ratings shall meet or exceed:
 - 1. 15 KVA – 97.89%
 - 2. 30 KVA – 98.23%
 - 3. 45 KVA – 98.40%
 - 4. 75 KVA – 98.60%
 - 5. 112.5 KVA – 98.74%
 - 6. 150 KVA – 98.83%
- I. Sound Level: Sound levels shall not exceed the following: 150 KVA and below, 50 db; above 150 KVA, 60 db.
- J. Transformers shall have the following features and ratings:
 - 1. Enclosures shall meet UL 506 requirements.
 - 2. Enclosure: Indoor, ventilated, drip proof in electric rooms.
 - 3. Enclosure: Outdoor, ventilated raintight, NEMA 3R.
 - 4. Insulation Class: 185°C class for 37½ KVA transformers or smaller; 220°C class for transformers larger than 37½ KVA.
 - 5. Insulation Temperature Rise: 150°C maximum rise above 40°C, for 220°C class insulation; 115°C maximum rise for 185°C class insulation.
 - 6. Taps: For transformer 3KVA and larger, full capacity taps in high-voltage winding as follows:
 - a. 3 KVA through 30 KVA: Four 2.5% taps, two above and two below normal voltage.
 - b. 30 KVA through 500 KVA: Four 2.5% taps, two above and two below rated normal voltage.
- K. Accessories: As follows:
 - 1. Weather shield kits for the ventilated transformer Type 3R.
- L. Transformers: Factory assembled and tested air-cooled units of types specified, having characteristics and ratings as indicated on drawings. Units shall be designed for 60 Hz service.
- M. Transformer core shall be constructed of high grade grain oriented silicon steel.

- N. Coils shall use high grade magnet wire. Coils shall have clearly marked terminal pads attached to a rugged fiberglass termination strip. Windings shall be vacuum impregnated with nonhydroscopic thermosetting varnish for superior strength and heat transfer.
- O. Transformer shall have (2) 2.5 percent above nominal and (4) 2.5 percent below nominal universal full capacity taps.
- P. Insulation system shall be UL Recognized at 220 degree C and shall be capable of continuous operation at 40 degree C ambient without windings exceeding 150 degree C temperature rise. Surface temperature rise shall not exceed UL 50 degree C limit. Wiring compartment temperature rise shall not exceed UL 35 degree C limit.
- Q. Floor-mount enclosure shall be constructed of heavy-gauge steel for indoor use. Weathershield kits shall be available to modify enclosures for NEMA 3R outdoor use.
- R. Wiring compartment shall be sized for aluminum cable rated 125 percent of current, using long shanked crimp type connectors. Wiring compartment shall be accessible by removing enclosure front panel.
- S. Vibration from core and coil assembly shall be isolated from enclosure by neoprene vibration pads and sleeves. A flexible copper grounding strap shall connect core to enclosure. A schematic connection diagram shall be located on enclosure nameplate for quick referral.
- T. A premium electrostatic shield shall be included, consisting of a full width copper sheet placed between primary and secondary windings. Effective coupling capacitance shall be thirty picofarads. Average common mode noise attenuation shall be 120 db.
- U. A rugged filter shall provide an average 60 db normal mode noise attenuation.
- V. Surge suppression components shall be included to eliminate low-voltage spikes and surges.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Arrange equipment to provide adequate spacing for cooling air circulation.
- B. Identify transformers in accordance with Division 26 Section "Electrical Identification." Include on label, location of primary overcurrent protection device.
- C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.2 EQUIPMENT BASES

- A. Construct concrete equipment pads as follows:
1. Coordinate size of equipment bases with actual unit sizes provided. Construct base 4-inches high and 2-inches larger in all directions than the overall dimensions of the supported unit.
 2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
 3. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.
 4. Place concrete and allow to cure before installation of units. Use Portland Cement conforming to ASTM C 150, 4000 psi compressive strength, and normal weight aggregate.

3.3 STRUCTURAL REVIEW

- A. Based on submitted transformers, the Contractor shall submit intended structural support details to the project structural engineer to review to confirm structure is adequate.

3.4 GROUNDING

- A. Ground transformers and tighten connections to comply with torque tightening requirements specified in UL Standard 486A.

3.5 FIELD QUALITY CONTROL

- A. Inspect for physical damage, broken insulation, tightness of connections, defective wiring, and general condition.
- B. Thoroughly clean unit prior to making any tests.
- C. Perform insulation-resistance test. Calculate dielectric absorption ratio and polarization index. Make measurements from winding-to-winding and winding-to-ground. Test voltages and minimum resistance shall be in accordance with Table below:

Minimum dc Test Voltage	Recommended Minimum Insulation Resistance in Megohms
1000-Volts	500

- D. Verify taps and connect transformer to desired tap, if applicable.

- E. Energize primary winding with system voltage. Measure secondary voltage with the secondary load disconnected. Record results.
- F. All transformers shall have a disconnecting means on the primary side of the transformer. If the disconnecting means is in a remote location or not within direct line of site of the transformer, the contractor shall provide a permanent phenolic label on the transformer with 3/4" black lettering on a white background. The label shall indicate the room name and number indicating where the remote disconnect is located.

3.6 INFRARED INSPECTION (AFTER ENERGIZED)

- 1. The scan is to include all electrical distribution equipment.
- 2. All equipment should be energized at normal load levels during an event for at least 1 to 2 hours prior to being scanned.
- 3. Access covers are to be removed and reinstalled by the electrical Contractor for the testing agency to inspect and scan all electrical junctions, buss, and cable.
- 4. The IR Scan will be made using a Flir Thermal Imaging Camera. The camera shall provide infrared photos clearly indicating problem areas.
- 5. All problem areas will be noted as to location, description, and recommended solution by providing a typed report including infrared and digital pictures of all problem areas.

3.7 ADJUSTING AND CLEANING

- A. Upon completion of installation, inspect interiors and exteriors of accessible components. Remove paint splatters and other spots, dirt and construction debris. Touch up scratches and mars on finish to match original finish.
- B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment.

3.8 PROTECTION

- A. Temporary Heating: Apply temporary heat in accordance with manufacturer's recommendations within enclosure of each transformer throughout periods during which equipment is not in a space that is continuously under normal control of temperature and humidity.

END OF SECTION 26 22 13

SECTION 26 24 15 - SERVICE ENTRANCE SWITCHBOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

- A. Provide all switchboard, and enclosure work, including cabinets and cutout boxes, as indicated by drawings and schedules, and as specified herein.
- B. Wires/cables, busses, electrical boxes and fittings, and raceways required in conjunction with the installation of switchboard, and enclosures are specified in other Division 26 sections.
- C. All switchboards, panelboards, switchgears, transformers, disconnect switches, starters, etc., shall be fabricated by same manufacturer throughout the entire project unless specifically noted otherwise.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on switchboard and enclosures.
- B. Shop drawings showing dimensions, voltage, phasing, continuous current capacity, and short circuit rating.
- C. Submit electrical room plan, view drawings at 1/4" scale with all electrical equipment, end and front elevation views of switchboard showing circuit breakers and ratings, buss work, conduit areas, dimensions, recommended housekeeping pad sizes, mounting of equipment supplied.
- D. The equipment product data, main electrical room layout and short-circuit and coordination studies shall be submitted together in order to provide proper evaluation.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of switchboard and enclosures, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for no less than 5 years.
- B. Installer's Qualifications: Firms with at least 5 years of successful installation experience on projects utilizing switchboard similar to those required for this project.
- C. Codes and Standards:
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC as applicable to installation, and construction of switchboard and enclosures.
 - 2. UL Compliance: Comply with applicable requirements of UL 50, 869, 486A, 486B, 891, 1053, and 1066 pertaining to switchboard accessories and enclosures. Provide switchboard unit which are UL-listed and labeled.
 - 3. NEMA Compliance: Comply with NEMA Standards Pub/No. 250, "Enclosure for Electrical Equipment (1000-Volts Maximum)," and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Equipment Rated 600-Volts or Less."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store switchboard in a clean dry space. Protect units from dirt, fumes, water, construction debris and traffic; where necessary to store outdoors, store electrical components above grade and enclose with watertight wrapping.
- B. Handle switchboard carefully to prevent internal components damage, breakage, denting, and scoring enclosure finish. Do not install damaged components; replace and return damaged units to equipment manufacturer.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate installation of switchboard, and enclosures with installation of wires/cables, electrical boxes and fittings, and raceway work.

PART 2 - PRODUCTS

2.1 SWITCHBOARD

- A. The switchboard shall be designed, manufactured and tested in accordance with applicable standards of NEMA, ANSI, and IEEE. The enclosure shall be completely self-supporting, front and rear angle forming a single metal enclosed structure. The side, top and rear covers shall be

code-gauge steel and finished with medium gray (ANSI #61) paint applied over rust inhibiting phosphate primer. Frame structure members shall be die-formed, 11-gauge steel bolted together and reinforced at corners. Switchboard frames are to be suitable to be bolted to floor sills embedded in concrete. The equipment shall be totally adjusted and tested at the factory and sectionalized for shipment so that the largest section does not exceed 49-inches wide, 60-inches deep, and 90-inches high to enable installation at the job site.

1. Switchboards located at exterior locations and in parking garages shall be NEMA 3R.
- B. The switchboard shall be provided with load and line side mechanical lug terminations for incoming and outgoing cables.
- C. All switchboard bussing, devices, and connections shall be braced to withstand the maximum short circuit current available from the utility transformer. The switchboard shall be labeled to indicate the maximum available fault current rating, taking into account the structure, bussing, switchboard main disconnect(s), and switchboard branch circuit devices. The short circuit current rating of the switchboard(s) shall not be less than 65,000 RMS symmetrical amperes. The switchboard branch circuit devices short circuit current rating shall be fully rated.
- D. The switchboard through-buss shall be silver-plated copper. The switchboard bussing shall be of sufficient cross-sectional area to meet UL Standard 891 for temperature rise. The through-buss shall have an ampacity rating as indicated on one-line drawings and extended the full length of the switchboard. The through-buss shall be 100% rated. Provisions shall be provided for future splicing of additional sections. The neutral buss shall be 100% rated.
- E. The switchboard distribution section buss shall be of the same material as the through-buss and shall be fully rated. The distribution section neutral plate shall be of copper provided with Cu/Al lugs for the devices installed and future specified devices.
- F. A copper 1600A, (2) 0.25 x 3-inch ground buss shall be secured to each vertical section structure. Ground buss shall extend entire length of switchboard and shall be equipped with a terminal accommodating up to 250 Kcmil for connection to purchaser's ground system. A lug strap shall be provided for each vertical feeder section.
- G. Switchboard shall be separated into shipping blocks. Each switchboard section shall be capable of being handled individually with the use of removable lifting bars or rollers and be clearly labeled with proper handling procedures.
- H. Switchboard shall be arranged for connection to the supply source by cable with UL service entrance label, incoming line isolation and shall have side barriers between sections.
- I. Provide barrier so no uninsulated, ungrounded service busbar or service terminal is exposed.
- J. Breaker compartment doors shall be secured with two captive hex head screws.
- K. Provide cable supports for each vertical section.

- L. Bolted covers that can be bolted closed shall be provided for each cable compartment. Utility CT sections shall not be provided with hinged doors.
- M. Cable bending space shall meet National Electrical Code requirements. All switchboard sections shall have open bottoms and removable top plate(s) to install conduit.
- N. A-B-C buss arrangement (left-to-right, top-to-bottom, front-to-rear) shall be used throughout to assure convenient and safe testing and maintenance. Where special circuitry precludes this arrangement, buss bars shall be labeled.
- O. Breaker primary connections shall be copper-to-copper, silver-plated on stationary breakers.
- P. All feeder device line and load connections shall be rated to carry continuous current rating of device frame (not trip rating).
- Q. A utility metering compartment shall be supplied to meet requirements of the YVEA Utility Company. No additional cost to the Owner will be allowed for coordinating and meeting the local utility company requirements.
- R. Service Entrance shall comply with UL Service Entrance requirements: Service entrance label, incoming line isolation barriers and neutral connection to switchboard ground for solidly grounded wye systems. The switchboard shall be listed as suitable "For Use" as service entrance and not as "Only" for service entrance. The Neutral-Ground bond shall be capable of being isolated in the future.
- S. Incoming Line Section shall be rated as indicated in drawings. Main cable connection as shown on drawing.

2.2 CIRCUIT BREAKERS

- A. Main Breaker:
 - 1. The circuit breaker shall be fixed mounted, manually operated type with the frame and rating (100%) size as shown on the associated drawings. The breaker operating mechanism is to be of the two-step stored energy quick-make, quick-break type. First step operation of local "close" button is to close the breaker contacts. Closing of the breaker contact shall automatically charge the opening springs to insure quick-break operation. The trip unit shall be provided with adjustable long time, short time, instantaneous and ground fault trip functions.
 - 2. Main protective devices shall be low-voltage insulated case circuit breakers. All protective devices shall be UL 489 listed.
 - 3. All main and tie protective devices shall be in individual compartments.
 - 4. Provide energy reducing maintenance switching with local status indicators for a main breaker rated 1,200 amps and greater according to the requirements included in NEC 240.87.

5. Moveable Element: Breakers shall have manual trip button and position indicator. "Push to Close" button shall be located on front of breaker for easy access. Breaker shall be able to have all 3 primary breaker contacts padlocked in open position to prevent unauthorized breaker closing. In Test and connected positions, breaker element shall have positive ground to housing. Breakers with same frame sizes shall be interchangeable.

B. Feeder Circuit Breakers

1. Feeder circuit breakers shall be molded case circuit breakers with solid state (microprocessor) trip unit. The breaker shall be manually operated type frame and be stationary mounted. Line and load side circuit breaker connections are to be buss type. The trip unit shall be provided with adjustable long time, short time and instantaneous trip functions.
2. Provide energy reducing maintenance switching with local status indicators for each feeder breaker rated 1,200 amps and greater according to the requirements included in NEC 240.87.
3. Provisions for all controls, future accessories and communications shall be factory wired.
4. Breakers shall be suitable for reverse feeding.
5. Breakers shall have pad locking features.

2.3 SURGE PROTECTIVE DEVICE (SPD)

- A. Each switchboard shall be provided with a Surge Protective Device (SPD) exterior of enclosure and shall be UL 1449 Listed and CSA Approved. The SPD shall meet the requirements of Section 26 43 13 for service entrance.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine area and conditions under which switchboards, panelboards and enclosures are to be installed, and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SWITCHBOARD

- A. Install switchboards, panelboards, and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standards of Installation," and in compliance with recognized industry products fulfill requirements practices to ensure that.

- B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers' published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with torque tightening requirements specified in UL Standards 486A and B.
- C. Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically anchored.
- D. Provide properly wired electrical connections for switchboard.
- E. Provide engraved, plastic laminate labels for all switchboard indicating name, voltage, phase, wire and short circuit rating. In addition, each branch device on the switchboard shall be labeled (engraved). Refer to Section 26 05 53 for more information.
- F. Provide typed panelboard's circuit directory card upon completion of installation work to match as-built conditions and nomenclature indicated on engineering drawings and submit directories to the Engineer for review prior to mounting in panelboard.

3.3 RISER DIAGRAMS PLACARD

- A. Provide an electrical riser diagram for light and power framed under glass and mounted on the wall in the main electrical room. Prints shall be of the diffusion transfer process to eliminate fading.

3.4 SWITCHBOARD BASES

- A. Construct concrete equipment pads as follows:
 - 1. Coordinate size of equipment bases with actual unit sizes provided. Construct base 4-inches high and 2-inches larger in all directions that the overall dimensions of the supported unit. The highest switch shall not exceed 6'-6" above the floor when installed on the pad.
 - 2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
 - 3. Install reinforcing bars, channel sills embedded into concrete to tie to frame, and place anchor bolts and sleeves to facilitate securing units.
 - 4. Place concrete and allow to cure before installation of units. Use cement conforming to ASTM C 150, 4000 psi compressive strength, and normal weight aggregate.

3.5 GROUNDING

- A. Provide equipment grounding connections for switchboard enclosures as indicated herein. Tighten connection to comply with torque tightening requirements specified in UL 486A to assure permanent and effective grounds.
- B. Refer to Section 26 05 26 for additional grounding requirements.

3.6 FIELD QUALITY CONTROL

Tests shall conform to International Electrical Testing Association (INETA) Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment."

- A. Infrared Inspection (After Energized):
 - 1. The scan is to include all electrical switchboard field connections to buss bars and loads.
 - 2. All equipment should be energized at normal load levels for at least 1 to 2 hours prior to being scanned.
 - 3. Access covers are to be removed and reinstalled by the electrical contractor for the Engineer to inspect and scan all electrical junctions, buss, and cable.
 - 4. The IR Scan will be made using a Flir Thermal Imaging Camera. The camera shall provide infrared photos clearly indicating problem areas.
 - 5. All problem areas will be noted as to location, description, and recommended solution by providing a typed report including infrared and digital pictures of all problem areas.
- B. Switchboard:
 - 1. Visual and mechanical Inspection:
 - a. Inspect for physical damage and code violations.
 - b. Inspect for proper alignment, anchorage and grounding.
 - c. Inspect for proper identification of protective devices and switches.
 - d. Check tightness of accessible bolted buss joints.
 - e. Physically test all electrical or mechanical interlocks to assure proper function.
 - f. Clean interior and insulator surfaces.
 - g. Inspect for proper operation of space heaters and thermostat settings (if they exist).
 - 2. Electrical Tests:
 - a. Measure insulation resistance of each buss section phase-to-phase and phase-to-ground.
 - b. Check switchboard for electrical continuity of circuits and for short circuits.

C. Circuit Breakers:

1. Visual and Mechanical Inspection:

- a. Inspect for physical damage.
- b. Mechanical operational test will be made in accordance with manufacturer's instructions.
- c. Check tightness of all hardware connections.
- d. Check cell fit and element alignment.

2. Electrical Tests:

- a. Measure contact resistance.
- b. Check the following functions by primary current injection.
 - 1) Measure minimum long-time pickup when possible.
 - 2) Measure long-time delay at three (3) times long-time pickup current.
 - 3) Measure short-time pickup.
 - 4) Measure short-time delay at 1½ times short-time pickup current.
 - 5) Measure instantaneous pickup.
 - 6) Measure ground fault pickup.
 - 7) Measure ground fault delay at 1½ times ground fault pickup.
 - 8) Check trip unit reset operation.
- c. Perform insulation resistance test phase-to-ground, phase-to-phase and across open contacts.
- d. Metering and instrumentation
 - 1) Visual and mechanical inspection.
 - a) Check all devices for physical damage and connection tightness.
 - b) Verify meter nameplate designation.
- e. Electrical Tests
 - 1) Check calibration of all panel meters at zero, mid-scale and full-scale deflections by transfer standard.
 - 2) Check calibration of watt-hour meters for proper registration by use of rotating standard at light, heavy, and 50% power conditions.
 - 3) Verify all instrument multipliers and scale factors.

3.7 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finishes.

3.8 DEMONSTRATION

- A. Subsequent to wire and cable hook-ups, energize switchboard and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION 26 24 15

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 26 Basic Electrical Material and Methods sections apply to work specified in this section.

1.2 SUMMARY

- A. Provide all panelboards and enclosure work, including cabinets and cutout boxes, as indicated by drawings and schedules, and as specified herein.
- B. Types of panelboards, and enclosures required for the project include the following:
 - 1. Power-distribution panelboards.
 - 2. Lighting and appliance panelboards.
- C. All switchboards, panelboards, switchgears, transformers, disconnect switches, starters, etc., shall be fabricated by same manufacturer throughout the entire project unless specifically noted otherwise.
- D. Wires/cables, bus-way, electrical boxes and fittings, and raceways required in conjunction with the installation of panelboards, and enclosures are specified in other Division 26 sections.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on panelboards, and enclosures.
- B. Wiring Diagrams: Submit wiring diagrams for panelboards showing connections to electrical power feeders and distribution branches.
- C. Submit electrical room plan view drawings at 1/4" scale showing all equipment, panelboards, disconnects and ratings, buss work, conduit areas, dimensions and mounting of equipment supplied.
- D. Shop drawings showing dimensions, voltage, phasing, continuous current capacity, and short circuit rating.

- E. The equipment product data, electrical room layouts and short-circuit study shall be submitted together in order to provide proper evaluation.
- F. Submittals shall be in accordance with specification section 26 05 00.

1.4 QUALITY ASSURANCE

- A. **Manufacturer's Qualifications:** The manufacturer of this equipment shall be regularly engaged in manufacture of panelboards and enclosures, of types, sizes, and ratings required and have produced similar electrical equipment, for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. **Codes and Standards**
 - 1. **Electrical Code Compliance:** Comply with applicable local code requirements of the authority having jurisdiction and NEC Article 384 as applicable to installation, and construction of electrical panelboards and enclosures.
 - 2. **UL Compliance:** Comply with applicable requirements of UL 67, "Electric Panelboards", and UL's 50, 869, 486A, 486B, 891, and 1053 pertaining to panelboards, accessories and enclosures. Provide panelboard units which are UL-listed and labeled.
 - 3. **Special-Use Markings:** Provide panelboards, constructed for special-use, with appropriate UL markings which indicated that they are suitable for special type of use/application.
 - 4. **NEMA Compliance:** Comply with NEMA Standards Pub/No. 250, "Enclosure for Electrical Equipment (1000-Volts Maximum)", Pub/No. PB 1, "Panelboards", and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600-Volts or Less".

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store panelboards in clean dry space. Protect units from dirt, fumes, water, construction debris and traffic; where necessary to store outdoors, store electrical components above grade and enclose with watertight wrapping.
- B. Handle panelboards carefully to prevent internal components damage, breakage, denting, and scoring enclosure finish. Do not install damaged components; replace and return damaged units to equipment manufacturer.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate installation of panelboards and enclosures with installation of wires/cables, electrical boxes and fittings, and raceway work.

PART 2 - PRODUCTS

2.1 PANELBOARDS (800 AMPS OR LESS)

- A. General: Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated on drawings, which comply with manufacturer's standard materials; with the design and construction in accordance with published product information; equip with proper numbers of unit panelboard devices as required for complete installation.
1. Prefabricated or pre-wired panelboards are not acceptable.
- B. Power Distribution Panelboards: Provide dead-front safety type power distribution panelboards as indicated, with panelboards switching and protective devices in quantities, ratings, types, and with arrangement shown; with anti-turn solderless pressure type main lug connectors approved for use with copper conductors. Select unit with feeders connecting at top of panel. Equip with copper buss bars with not less than 98% conductivity, and with full-sized neutral buss; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connection. Provide molded-case main and branch circuit-breaker types for each circuit, with toggle handles that indicated when tripped. Where multiple-pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Where multiple single pole breakers share a common neutral conductor, provide breaker tie bars as required so overload on one pole will trip all poles simultaneously. Provide panelboards with bare un-insulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturers as panelboards, which mate and match properly with panelboards. Employ bolt on breakers that are fully rated for the available short-circuit condition but of not less than 22,000 sym AIC.
- C. Lighting and Appliance Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types and arrangements shown. Equipped with anti-turn solderless pressure type lug connectors approved for use with copper conductors; construct unit for connecting feeders at top of panel; equip with copper buss bars, full-sized neutral bar, with bolt-in type heavy-duty, quick-make, quick-break, single-pole circuit breakers, with toggle handles that indicate when tripped. Provide suitable lugs on neutral buss for each outgoing feeder required; and provide bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturers as panelboards, which mate and match properly with panelboards.
1. Employ breakers that are fully rated for the available short-circuit condition but not less than 10,000 sym AIC at 120/208-Volts; and 14,000 sym AIC at 277/480-Volts.
 2. Where multiple single pole breakers share a common neutral conductor, provide breaker tie bars as required so overload on one pole will trip all poles simultaneously.
 3. All circuit breakers feeding food service loads or vending machines shall be GFCI type.
- D. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage, minimum 16-gage thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps, and doors with flush

locks and keys, all panelboard enclosures keyed alike, with concealed piano door hinges with door in door swings as indicated. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for surface mounting. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.

- E. Molded-Case Circuit Breakers: Provide factory-assembled, molded-case circuit breakers of frame sizes, characteristics, and ratings including RMS symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and ampere ratings as indicated on the drawings. Construct with overcenter, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position, and operating in ambient temperature of 40°C. Provide breakers with mechanical screw or compression type removable connector lugs, AL/CU rated. The breakers for 277/480V panelboards shall be industrial grade; breakers that allow or direct particles of combustion resulting from fault conditions out of the breaker are not acceptable, they shall be contained within its casing. For example; GE AE series panelboards with TEY circuit breakers are not acceptable, TED breakers are acceptable.
 - 1. Breakers feeding the primary side of a transformer shall have provisions for locking the breaker on or off.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine area and conditions under which panelboards and enclosures are to be installed, and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standards of Installation" and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers' published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with torque tightening requirements specified in UL Standards 486A and B.
- C. Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically anchored.

- D. Provide properly wired electrical connections for panelboards within the enclosures.
 - 1. Prefabricated or pre-wired panelboards are not acceptable.
- E. Provide engraved, plastic laminate labels for all panelboards indicating name, voltage, phase, wire and short circuit rating. Refer to Section 26 05 53 for more information.
- F. At all recessed panel locations, provide three ¾" spare conduits stubbed to the accessible ceiling space for future use.
- G. Provide typed panelboards circuit directory card upon completion of installation work to match as-built conditions and nomenclature indicated on engineering drawings and submit directories to the Engineer for review prior to mounting in panelboard.

3.3 GROUNDING

- A. Provide equipment grounding connections as indicated herein. Tighten connection to comply with torque tightening requirements specified in UL Standard 486A to assure permanent and effective grounds.
- B. Refer to Section 26 05 26 for additional grounding requirements.

3.4 FIELD QUALITY CONTROL

Tests shall conform to International Electrical Testing Association (INETA) Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment".

- A. Infrared Inspection (After Energized)
 - 1. The scan is to include all electrical panelboards or bussed distribution equipment.
 - 2. All equipment should be energized at normal load levels during an event for at least 1 to 2 hours prior to being scanned.
 - 3. Access covers are to be removed and reinstalled by the electrical Contractor for the testing agency to inspect and scan all electrical junctions, buss, and cable.
 - 4. The IR Scan will be made using a Flir Thermal Imaging Camera. The camera shall provide infrared photos clearly indicating problem areas.
 - 5. All problem areas will be noted as to location, description, and recommended solution by providing a typed report including infrared and digital pictures of all problem areas.
- B. Panelboards:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect for physical damage and code violations.
 - b. Inspect for proper alignment, anchorage and grounding.

- c. Inspect for proper identification of protective devices and switches.
- d. Check tightness of accessible bolted buss joints.
- e. Physically test all electrical or mechanical interlocks to assure proper function.
- f. Clean interior and insulator surfaces once a month prior to job completion.
- g. Inspect for proper operation of space heaters and thermostat settings (if they exist).

2. Electrical Tests:

- a. Measure insulation resistance of each buss section phase-to-phase and phase-to-ground.
- b. Check panelboards for electrical continuity of circuits and for short circuits.

3.5 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finishes.

3.6 DEMONSTRATION

- A. Subsequent to wire and cable hook-ups, energize and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION 26 24 16

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles
 - 2. Ground-Fault Circuit-Interrupter Receptacles
 - 3. Plugs
 - 4. Plug Connectors
 - 5. Snap Switches
 - 6. Wall Plates Wall Plates
 - 7. Occupancy Sensors
 - 8. Floor Boxes
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Division 26 Section "Motor Disconnects and Fuses" for devices other than snap switches and plug/receptacle sets used as disconnects for motors.

1.3 SUBMITTALS

- A. Product data for each type of product specified.
- B. Shop Drawings / Architectural Coordination Requirements:
 - 1. Floor box locations and types indicated on drawings are schematic in nature and are not dimensioned locations. Contractor shall submit shop drawings and product data for final review and comment by the Architect, Owner, and Engineer, to ensure desired aesthetics are achieved.
 - 2. Shop drawings shall include the following detailed information:
 - a. Placement: Dimensioned floor box placement shown on floor plan with current furniture layer shown.

- b. Conduit: Show all conduit size and routing with labels for power, data, etc.
 - c. Covers: Specific labels or notes to indicate where different cover types and finish are to be used, if applicable.
- 3. Occupancy Sensors Wired
 - a. Submit a lighting plan clearly marked by manufacturer identifying product type, locations, orientation and coverage for each sensor.
 - b. Submit any interconnection diagrams per major subsystems showing proper wiring.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with provisions of the following codes.
 - 1. NFPA 70 "National Electrical Code."
- B. UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL, Federal Specification and comply with applicable UL and NEMA standards.
 - 1. UL 943

1.5 SEQUENCE AND SCHEDULING

- A. Schedule installation of finish plates after the surface upon which they are installed has received final finish.

PART 2 - PRODUCTS

2.1 WIRING DEVICES

- A. General: Provide wiring devices, in types, characteristics, grades, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards.
- B. Color of Devices: Color of all devices shall be coordinated with the Architect, except special purpose devices shall be black, Stand-by power system devices which shall be red.
- C. Receptacles: As scheduled in Table 1 in Part 3 indicated herein. Comply with UL 498 and NEMA WD 1 and WD 6. Damp and wet location receptacles to be listed as weather resistant. Plug tail devices are not acceptable.
- D. Receptacles, Industrial Heavy Duty: Provide pin and sleeve design receptacles conforming to UL 498. Comply with UL 1010 where installed in hazardous locations. Provide features indicated.

- E. Receptacles, USB charging type: 2 port, 5 Amp minimum, 5-Volt D.C, WR rated as required.
- F. Ground-Fault Circuit-Interrupter (GFCI) Receptacles: As scheduled in Table 1 in Part 3 indicated herein: Provide "terminal" or feed-through type ground fault circuit interrupter, as indicated on drawings, with integral heavy-duty NEMA 5-20R duplex receptacles. Provide unit designed for installation in a 2-3/4-inch-deep outlet box without adapter, grounding type, Class A, Group 1 per UL Standard 943 including self-testing.
- G. Snap Switches: As scheduled in Table 2 in Part 3 indicated herein.
- H. Wall Dimmer: As scheduled in Table 2 in Part 3 indicated herein.
 - 1. Incandescent wall dimmers shall be 120-Volt, solid state type with slide control handle, preset button and semi-flush mounting. Dimmers shall be sized to continuously carry the load they are connected to, the minimum size shall be 1000 watts, and shall be rated larger if indicated on the drawings or required to serve the load.
 - 2. Dimmers indicated on the drawings to serve low-voltage incandescent lamps shall be the same as specified for incandescent lamps and in addition shall be specifically rated for the low-voltage transformer load. Dimmer shall be UL listed for use with low-voltage fixtures.
 - 3. Dimmers indicated to serve fluorescent lamps shall be 120v or 277v, as required for circuit served, solid state type for use with fluorescent dimming ballasts. Control shall be slide handle and dimmer shall be for semi-flush mounting.
 - 4. Dimmers indicated to serve 0-10V loads shall be 120V or 277V, as required for circuit served, solid state type for use with 0-10V ballasts/drivers. Control shall be slide handle and dimmer shall be for semi-flush mounting.
 - 5. All dimmers shall be of the same manufacturer. Faceplate shall be the same color as device plates specified.
- I. All exterior weatherproof receptacles located on the roof, receptacles located in elevator pits and machine rooms shall be GFCI type or GFCI protected and have cast metallic "in use" covers.
- J. All devices shall be premium specification grade. OCCUPANCY SENSORS

2.2 OCCUPANCY SENSORS

- A. Layouts shown on plan drawings are intended to show general control concepts (i.e., wall sensors, ceiling sensors, or switch sensor) for an area. The contractor shall provide sensor coverage of the entire space based on the concept shown, as well as all other devices required (power packs, control wiring, switching, etc.) for a complete and working system. Low voltage switching to allow local override of the sensors shall be provided at all entries to areas shown as controlled by ceiling or wall mounted sensors. In areas that require two or more sensors for full coverage, the sensors shall be interconnected together to provide a single switching zone for the entire space, regardless of the number of circuits.

- B. Wall switch sensor shall be capable of detection of occupancy up to 300 square feet and gross motion up to 1000 square feet. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 Volts, 0 to 1200 watts at 277 Volts and shall have 180° coverage capability. All wall switches shall utilize zero crossing circuitry, field deselectable option (automatic – on to manual on).
- C. Wall dimmer sensor shall be capable of detection of occupancy up to 300 square feet and gross motion up to 1000 square feet. Wall dimmer sensor shall accommodate loads from incandescent, halogen, MLV, ELV and 0-10V.
- D. Ceiling mounted sensors shall be dual technology (passive infrared and ultrasonic). The sensor shall offer day lighting foot candle adjustment control and be able to accommodate dual level lighting. Sensors shall be immune to false triggering from RFI and EMI.
- E. All sensors shall utilize automatically adjustable time delay and sensitivity settings. Settings shall be located on sensor.
- F. In the event of failure, a bypass override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall diver to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.
- G. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both test and normal operation.
- H. Sensors shall have an internal additional isolated relay with normally open, normally closed and common outputs for use with HVAC control, data logging and other control options.

2.3 FLOOR BOXES

- A. General Information:
 - 1. Poke Thrus and Cast-in-place floor boxes shall be manufactured with all metal die-cast aluminum construction or steel with die-cast aluminum covers. Devices shall be designed to fit in core hole opening or be cast in place.
 - 2. Covers shall be manufactured with all metal die-cast aluminum or solid metal finish construction. At a minimum, device cover shall be available in the following options; Black, Gray, Nickel, Brass, Bronze and Brushed Aluminum.
 - 3. Miscellaneous: Specific device mounting plates and bottom housing assemblies shall be provided for various applications. Contractor shall be load rated for 1000 pounds and provide all components per drawings and/or manufacturer recommendations for a complete solution. Refer to Power and/or Technology drawing details for additional information.

B. Poke-Thru Device (Power / Low Voltage)

1. Application: Elevated slab floor mounted device locations and Modular Furniture Feed floor mounted device locations, as applicable. 6-inch poke-thru shall be used for power only or power/data locations. 8-inch poke-thru shall be used (as applicable) for any locations with AV connectivity.
2. Fire Rating: Poke Through shall be UL listed for use in 2 hour fire rated floors (minimum).
3. Conduit Openings: Poke Thru shall have through floor fitting with a minimum of (1) 3/4-inch conduit for power and pass through channels for low-voltage cabling.
4. Flexible Conduit Feed: Black 2-inch Polytuff flexible conduit shall be provided to extend low-voltage device cabling from floor box knock-out to modular furniture, as applicable.

Products: Refer to Appendix 1 Floor Box Equipment Schedules for a list of benchmark manufacturer's part numbers.

C. Cast-in-place Furniture Feed Floor Box (Power / Low Voltage)

1. Application: Cast-in-place or slab on grade furniture feed device locations.
2. Compartments: 2-compartment floor box to support power and low-voltage systems such as voice/data.
3. Fire Rating: No Rating.
4. Conduit Openings: Each compartment of floor box shall have knock-outs ranging from 3/4 inch (for power) up to 2 inch (for low-voltage cabling).
5. Flexible Conduit Feed: Black 2-inch Polytuff flexible conduit shall be provided to extend low-voltage device cabling from floor box knock-out to modular furniture, as applicable.

Products: Refer to Appendix 1 Floor Box Equipment Schedules for a list of benchmark manufacturer's part numbers.

D. Cast-in-place Floor Box (Power / Low Voltage)

1. Application: Cast-in-place or slab on grade floor box locations.
2. Compartments: 4-compartment floor box to support power and low-voltage systems such as voice/data.
3. Fire Rating: No Rating.
4. Conduit Openings: Each compartment of floor box shall have knock-outs ranging from 3/4 inch (for power) up to 1-1/4 inch (for low-voltage cabling).

Products: Refer to Appendix 1 Floor Box Equipment Schedules for a list of benchmark manufacturer's part numbers.

E. AV Cast-in-place Floor Box (Power / Low Voltage)

1. Application: Cast-in-place or slab on grade floor box locations with AV components.
2. Compartments: 6-compartment floor box to support power and low-voltage systems such as voice/data and audio/visual.

3. Fire Rating: No Rating.
4. Conduit Openings: Each compartment of floor box shall have knock-outs ranging from 3/4 inch (for power) up to 2 inch (for low-voltage cabling).

Products: Refer to Appendix 1 Floor Box Equipment Schedules for a list of benchmark manufacturer's part numbers.

2.4 WIRING DEVICE ACCESSORIES

- A. Wall Plates: Single and combination, of types, sizes, and with ganging and cutouts as indicated. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide plates possessing the following additional construction features:
 1. Material and Finish: 0.03-inch-thick, type 302 satin finished stainless steel. Plate shall be Hubbell "S" Series or approved equal.
 2. Emergency receptacles shall have red cover plates.
- B. For all devices installed which are exposed to the weather, moisture or where indicated on the drawings, device plates shall be weatherproof. Device cover plates shall be cast metallic in-use type with gasketing to prevent entrance of moisture when closed.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES AND ACCESSORIES

- A. Install wiring devices and accessories as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work.
- C. The mounting height of devices is indicated in the legend on the drawings. Where finished walls are exposed concrete block, brick or tile, the height shall be adjusted to allow outlet box for device to be mounted at a joint.
- D. Receptacles above countertops shall be installed with major axis horizontal above the backsplash.
- E. Install GFCI receptacles or GFCI breakers in all areas as required per NEC 210.8, including but not limited to bathrooms, kitchens, rooftops, outdoors, within 6 feet of a sink, locker rooms, garages, crawl spaces and unfished occupied areas of basements.

- F. Install tamper resistance on 15& 20A 120V receptacles in all areas as required per NEC 406.12, including but not limited:
 - 1. Child care facilities
 - 2. Education facilities
 - 3. Business offices, corridors, waiting rooms and the like in clinics
 - 4. Medical office corridors and waiting rooms, and out patient facilities
 - 5. Public areas of assembly occupancies
- G. Mount all devices within outlet boxes to allow device plates to be in contact with wall on all sides. Align devices with major axis of device parallel to adjacent predominant building feature, i.e., door frames or countertops.
- H. Install wall switches on the strike side of doors.
- I. Install wiring devices only in electrical boxes which are clean; free from building materials, dirt, and debris.
- J. Provide a current carrying conductor, neutral, equipment grounding conductor and an insulated grounding conductor to each isolated ground "IG" receptacle.
- K. Install galvanized steel wall plates in unfinished spaces.
- L. Install wiring devices after wiring work is completed.
- M. Install wall plates after painting work is completed.
- N. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torque requirements are not indicated, tighten connectors and terminal to comply with tightening torque requirements specified in UL Standard 486A. Use properly scaled torque indicating hand tool.
- O. Provide hardwire connection to all modular furniture system power entry cables.

3.2 PROTECTION

- A. Protect installed components from damage. Replace damaged items prior to final acceptance.

3.3 FIELD QUALITY CONTROL

- A. Testing: Prior to energizing circuits, test wiring for electrical continuity, and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energizing test wiring devices and demonstrating compliance with requirements, operate each operable device at least six times.

- B. Test ground-fault interrupter operation with both local and remote fault simulations in accordance with manufacturer recommendations.
- C. TABLE 1

RECEPTACLES

Designation (1)	Current Rating Amps	Voltage Rating	Single/ Duplex	NEMA Config.	Hubbell Catalog #(3)	Notes
-	20	125	Duplex	5-20R	HBL5362	-
-	20	125	Single	5-20R	HBL5361	-
-	20	125	Duplex	5-20R	HBL5362C2	(7)
USB	20	125	Duplex	5-20R	USB20AC5	(6)
IG	20	125	Duplex	5-20R	IG5362	Isolated Ground
WP	20	125	Duplex	5-20R	GFR5362SG/ WP826 (4)	In Use Weather- proof
GFCI	20	125	Duplex	5-20R	GF5362SG	Integral GFCI (2)
-	20	125	Duplex	5-20R	HBL5362SA	Surge Suppression
-	20	125	Duplex	5-20R	HBL8300SGA	Tamperproof

NOTES

- Letter designations are used where symbols alone do not clearly designate on plans locations where specific receptacle types are used.
- Protecting downstream receptacles on same circuit is not acceptable.
- Refer to Section 26 05 03 for additional acceptable manufacturers. Color of device shall be verified with Architect (ivory, gray, white, etc.). All emergency receptacles shall be red.
- Where required per NEC or local code, provide Hubbell 'WP26E' in-use water-proof cover for two-gang devices.
- Where receptacles are located in damp or wet locations per article 406 in the National Electric Code, provide receptacles that are listed weather resistant. Use Hubbell HBL5362WR or approved equal receptacles where GFCI is not required at the receptacle location. Use Hubbell GFR5362 or approved equal where GFCI is required at the receptacle location.
- Provide USB20AC5WR as required where weather resistance is needed.
- Controlled receptacles shall be marked with power symbol and labeled as "Controlled" as required by the NEC 406.3E.

D. TABLE 2

SNAP SWITCHES

Designation (1)	Typical Application	Load Rating	Voltage Rating (AC)	Poles	Hubbell Catalog #(3)	Notes
S	Control Lights	20A	120/277	1	HBL1221	-
S3	Control Lights	20A	120/277	3-way	HBL1223	-
S4	Control Lights	20A	120/277	4-way	HBL1224	
Sp	Switch and Pilot Light	20A	120/277	1	HBL1221PL	(2)
Sk	Key Switch	20A	120/277	1	HBL1221L	
Swp	Wp Switch and Cover Plate	20A	120/277	1	HBL1281/HBL 1750	

NOTES

- For snap switches, designation is the same as the symbol used on plans for the device. Type of switch is determined from plan context including type of device or circuit being controlled.
- Pilot light “on” when switch is “on.”
- Hubbell basis of design. Refer to Section 26 05 03 for additional acceptable manufacturers. Color of device shall be verified with Architect (black, gray, white, etc.).

E. TABLE 3

WALL BOX SENSORS/DIMMER SWITCHES

Load Type (1)	Load Rating	Voltage Rating (AC)	Lutron Part # (2)	Notes
Occ/Vac Sensing 0- 10v Dimmer	8A	120/277	MRF2S-8SD010-XX	
Occ/Vac Sensing Switch	8A	120/277	MRF2S-8SS-XX	
Switch	8A	120/277	MRF2S-8S-DV-XX	
CFL/LED Incandescent/MLV Dimmer	150W CFL/LED 600W Inc/MLV	120	MRF2S-6CL-XX	

Load Type (1)	Load Rating	Voltage Rating (AC)	Lutron Part # (2)	Notes
Incandescent/MLV Dimmer	600W	120	MRF2S-6ND-120-XX	
ELV Dimmer	150W LED 600W ELV	120	MRF2S-6ELV120-XX	

NOTES

1. Provide dimmer wattage size to handle load served. Derate dimmer switch per manufacturer's recommendations where dimmers are ganged together. Provide dimmer model as required based on application, i.e., voltage rating, load, and load type.
2. Lutron basis of design. Refer to Section 26 05 03 for additional acceptable manufacturers. Color of device shall be verified with Architect (black, gray, white, etc.)

END OF SECTION 26 27 26

APPENDIX 1 - FLOOR BOX EQUIPMENT SCHEDULE

NOTES:

1. This specification is intended to be performance based, thus all products listed in the table below are benchmark products. Hubbell's equivalent products are acceptable. Contractor may propose other alternate manufacturers and/or models, but alternates are subject to approval by the Owner, Engineer, and/or Architect.
2. Contractor shall provide complete solution including all necessary components for installation of power and low-voltage systems. Refer to power and low-voltage drawings and/or drawing details and manufacturer recommendations for additional information.

Table 3.1 - Poke-Thru Floor Boxes			
Item	Part Name/Description	Manufacturer	Part Numbers
1	6-inch Poke-Thru Device	Legrand / Wiremold	6ATCFFxx, 6ATC2Pxx, 6AT2Pxx, 6PPS
2	6-inch Poke-Thru Center Mount Device Plates	Legrand / Wiremold	6B (blank), 6ACT8A (data)
3	8-inch Poke-Thru Device	Legrand / Wiremold	8ATC2Pxx, 8AT2Pxx, 8PPS
4	8-inch Poke-Thru Center Mount Device Plates	Legrand / Wiremold	8B (blank), 8ACT8A (data)

Table 3.2 - Cast-in-Place Furniture Feed Floor Boxes			
Item	Part Name/Description	Manufacturer	Part Numbers
1	Cast-in-place Furniture Feed (Power / Low Voltage)	Legrand / Wiremold	EFBFF-OG
2	Furniture Feed Floor Box Cover	Legrand / Wiremold	FPFFTCxx
3	Furniture Feed Floor Box Accessories (Divider, etc.)	Legrand / Wiremold	EFBFF-DIV

Table 3.3 - Cast-in-Place Floor Boxes			
Item	Part Name/Description	Manufacturer	Part Numbers
1	Cast-in-place Floor Box (Power / Low Voltage)	Legrand / Wiremold	RFB Series-OG (RFB4E-OG)
2	Floor Box Cover	Legrand / Wiremold	6CTC2xx, 6CT2Cxx
3	Floor Box Accessories (Low-Voltage mounting plates, Divider, etc.)	Legrand / Wiremold	Submit for approval (Refer to drawing details)

Table 3.4 - AV Cast-in-Place Floor Boxes			
Item	Part Name/Description	Manufacturer	Part Numbers
1	AV Cast-in-place Floor Box (Power / Low Voltage)	Legrand / Wiremold	EFB8S-OG
2	AV Floor Box Cover	Legrand / Wiremold	EFB610BTxx, EFB610CTCxx
3	AV Floor Box Accessories (Low-Voltage mounting plates, Divider, etc.)	Legrand / Wiremold	Submit for approval (Refer to drawing details)

SECTION 26 28 17 - COMPANY SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Section 26 05 02, "Basic Material and Methods", applies to work of this section.

1.2 SUMMARY

- A. Provide company switches with sizes as indicated on the drawings.
- B. Company switch shall be completely factory assembled as a unit.
- C. Company switch shall be manufactured by Union Connector, ESL Power Systems or approved equal.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on the company switches.
- B. Switch Product Data: Include construction details, material, dimensions and descriptions of individual components.
- C. Wiring Diagrams showing all internal wiring.
- D. Submit sample UL Listing label.

1.4 QUALITY ASSURANCE

- A. All equipment shall be in compliance with codes and standards referenced in Section 26 05 00 titled "Electrical Requirements".
- B. UL Compliance: Comply with requirements of UL 891, "Switchboards." Provide company switches which have been UL listed and labeled.
- C. UL Compliance: Comply with requirements of UL 498, "Attachment Plugs and Receptacles." Provide receptacles which have been UL listed and labeled.

- D. Comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," including, but not limited to, tightening of electrical connectors to torque values indicated.

PART 2 - PRODUCTS

2.1 COMPANY SWITCHES

- A. Company switches shall be dead front construction with integral main breaker and Cam-Lok type receptacles.
- B. All wiring within the company switch shall all be stranded copper and shall terminate at a copper bus.
- C. The Company Switch shall be designed and rated for 100% duty cycle at the specified ampacity.
- D. All company switches shall be NEMA 1 enclosed in interior locations. Provide NEMA 3R weatherproof enclosures where indicated on the drawings or exposed to exterior or damp locations.
- E. All company switches shall have a direct cable connection chamber. Chamber shall be lockable.
 - 1. Connection chamber shall accommodate dual rated mechanical lugs for connection of bare ended copper cables.
 - 2. Provide strain relief connection points for bare ended copper cable connections.
 - 3. Provide hinged trap door for cable access that can be secured with a latch only accessible from the inside of the enclosure.
- F. Slots shall be provided between each of the receptacles to prevent hysteresis currents.
- G. Provide either surface or recessed mounting. Refer to drawings for further details
- H. Wire bending space as required by the NEC.
- I. Company switch shall have UL label fixed to the exterior of the housing.
- J. Features:
 - 1. Phase indicator LED lights identifying when power is connected at each phase and to indicated ground integrity.
 - 2. Conduit knockouts.

3. Placard on each company switch indicating the connection and disconnection order as required by NEC 520.53 K (3)
4. Label indicating voltage, phase, source of power, AIC rating.

2.2 RECEPTACLES

- A. Furnish single pole Cam-Lok type receptacles in each company switch as indicated on the drawings. Each company switch shall accommodate three phase connections, a ground connection and a double neutral connection.
- B. Receptacles shall have the following properties:
 1. Rated at 600-Volts.
 2. NEMA 3R.
 3. Insulated housing.
 4. High impact resistant thermoplastic housing.
 5. Color coated:
 - a. Phase A:
 - b. Phase B:
 - c. Phase C:
 - d. Neutral:
 - e. Ground:
 6. Receptacles shall be of the following type:
 - a. J-Series 1016 type double cam brass connector. Refer to drawings for male or female quantities.
- C. Provide one set of matching plugs (turn around) for each company switch.

2.3 MAIN BREAKER

- A. Main breaker shall be UL listed 100% rated molded case type, fully rated at 65 kAIC at 240-Volts and 35 kAIC at 480-Volts. The breaker shall be manually operated type frame and be stationary mounted.
- B. Main circuit breaker shall be furnished with a lock out mechanism that shall accept 3rd party locks on built- in bracket for support of NFPA 70E safety lockout/tagout procedures.
- C. Main breaker handle shall be accessible from the front of the company switch without opening any doors or compartments.

PART 3 - EXECUTION

3.1 INSTALLATION OF COMPANY SWITCHES

- A. Install company switches as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.
- B. Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically anchored.
- C. Coordinate company switch installation work with electrical raceway and cable work, as necessary for proper interface.
- D. Provide engraved, plastic laminate labels for all company switches indicating name, voltage, phase, wire and short circuit rating. Refer to Section 26 05 53 for more information.

3.2 GROUNDING

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground for electrical company switches.
- B. Refer to Section 26 05 26 for additional grounding requirements.

3.3 FIELD QUALITY CONTROL

Tests shall conform to International Electrical Testing Association (INETA) Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment."

- A. Subsequent to completion of installation of electrical disconnect switches, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.
- B. Infrared Inspection (After Energized):
 - 1. The scan is to include all electrical company switch field connections to buss bars and loads.
 - 2. All equipment should be energized at normal load levels for at least 1 to 2 hours prior to being scanned.
 - 3. Access covers are to be removed and reinstalled by the electrical contractor for the testing agency to inspect and scan all electrical junctions, buss, and cable.

4. The IR Scan will be made using an FLIR camera. The camera shall provide infrared photos clearly indicating problem areas.
5. All problem areas will be noted as to location, description, and recommended solution by providing a typed report including infrared and digital pictures of all problem areas.

C. Load Bank Test

1. Perform a load bank test for each of the show power company switches as indicated below:
 - a. 2 hours at 50% of the rated switch capacity.
 - b. 2 hours at 90% of the rated switch capacity.
2. Test results shall be documented and given to the engineer for review and approval.

END OF SECTION 26 28 17

SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a UL Master Labeled, approved lightning protection system.

1.2 QUALITY ASSURANCE

- A. ANSI/NFPA 780; Lightning Protection Installation Standard
- B. ANSI/UL 96; Listed Lightning Protection Components.
- C. UL 96A; Installation Requirements for Lightning Protection Systems.
- D. Lightning Protection Institute (LPI) Standard 175

1.3 SYSTEM DESCRIPTION

- A. Lightning Protection System (LPS): A complete lightning protection system consisting of air terminals, interconnecting conductors, bonding, and grounding as required to obtain the UL Master Label. The LPS designer shall utilize the current IEC 62 305-2 standard to determine the geometric method to be employed in the design of the LPS. These calculations will determine the required Lightning Protection Level, the LPS class and ultimately the spacing of the air terminals. The calculations shall be included in the submittal package for the LPS to the engineer.

1.4 SUBMITTALS

- A. IEC 62 305-2 calculations used to determine the design criteria of the LPS.
- B. Submit shop drawings showing:
 - 1. Layout of all air terminals, grounding electrodes, conductor sizes and bonding connections to the structure and other metal objects.
 - 2. Shop drawings shall include shaded areas in plan view and section view noting the “area of protection” from higher roofs or other LPS equipment, where that “protection” has been designed utilizing zones of protection calculations. The method/formula and written calculations for determining each “area of protection” shall be included in the submittal package to the engineer.

- C. Submit product data that includes all pertinent information and the materials of each component, and include the current UL listing number in accordance with ANSI/UL 96.
- D. Submit manufacturer's detailed installation instructions.
- E. Submit the installers Statement of Work (SOW) detailing the plan of installation, from beginning to completion.
- F. Submit the UL documentation of the manufacturers' listing.
- G. Submit the UL documentation of the LPS installers' listing.

1.5 PROJECT RECORD DOCUMENTS

- A. Accurately record the actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors. The "as-built" drawings shall be submitted to the engineer along with the UL Master Label submittal at the completion of the system installation. This information shall also be submitted to the owner prior to project turnover as a part of the O & M documentation.

1.6 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in lightning protection equipment with minimum five (5) years experience, documented with their UL Listing. Refer to section 260503 for approved manufacturers.
- B. Installer:
 - 1. Authorized installer of manufacturer with minimum five (5) years documented experience with Underwriters Laboratories.
 - 2. Submit documentation of listing of the LPS installer with the UL Follow-Up Services include this documentation with the required shop drawings submittals.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Components: In accordance with ANSI/UL 96 AND NFPA 780.
 - 1. Air Terminals: Copper
Minimum Size Air Terminal for Class I Copper 3/8" x 12"
(Perimeter 20' Spacing Maximum and for equipment only)

- Minimum Size Air Terminal for Class II Copper 1/2" x 12"
(Perimeter 20' Spacing Maximum and for equipment only)
Minimum Size Air Terminal for Class I Copper 3/8" x 26"
(Mid-Roof 50' Spacing Maximum, braced)
Minimum Size Air Terminal for Class II Copper 1/2" x 26"
(Mid-Roof 50' Spacing Maximum, braced)
Perimeter and Mid-Roof Air Terminals shall be equipped with an anti-impalement adapter for safety.
2. Grounding Plate: Shall be Copper, Aluminum – not listed or approved
Minimum Acceptable Size Ground Plate 3' x 3' Square Foot Copper Plate
with factory installed pigtail
conductor with an irreversible
connection to the plate.
3. Conductors: Copper Solid or Stranded Conductors
Minimum Size Conductor for Class I Copper #2 Stranded
Minimum Size Conductor for Class II Copper 2/0 Stranded
Minimum Size Secondary CU Bonding Conductor #6 Solid
Minimum Size Conductor for Class I Aluminum 1/0 Stranded
Minimum Size Conductor for Class II Aluminum 4/0 Stranded
Minimum Size Secondary AL Bonding Conductor #4 Solid
4. All conductors within 18" of the ground shall be Copper.
5. Connectors and Irreversible Splicers: Bronze, Copper or Aluminum
6. Stamped connectors, splicers, bond plates or air terminal bases shall not be allowed in the LPS.
7. Ground Rods: UL Listed, Copper Clad Steel with irreversible cable to ground rod connections
8. Minimum Size Ground Rod 3/4" x 10"
9. Raceway shall have a minimum size of 1-1/4".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Beginning of installation means installer accepts existing conditions.

3.2 PROTECTION OF SURROUNDING ELEMENTS

- A. Protect elements surrounding the work of this Section from damage or disfiguration.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with UL 96A and ANSI/NFPA 780.
- C. The Lightning Protection System (LPS) shall be bonded to the grounding electrode systems according to the current National Electric Code (NEC).
- D. Install the LPS in a neat and workmanlike manner.
- E. Coordination with other trades.
 - 1. Roofing Contractor
 - a. Roofing contractor is responsible for pads and or pavers, if required by the roofing manufacturer.
 - b. Roofing contractor is responsible for sealing and flashing of roof penetrations for lightning protection system, to insure the roofing manufacturers' warranty.
 - c. Roofing contractor is responsible for communicating warranty requirements, to the LPS installer, in writing, before the installation of the lightning protection system begins.
 - 2. Electrical Contractor (EC)/General Contractor (GC)
 - a. EC/GC is responsible for sleeves through roofs, floors and out of foundations for the LPS down-conductors.
 - b. EC/GC is responsible for system requirements that need to be installed in various construction phases to allow for a complete and UL Master Label lightning protection system upon construction completion of the final construction phase.
 - c. EC is responsible for 1" conduit for down-conductors; conduit shall meet local code requirements of the AHJ. Structural steel shall not be utilized as the sole down-conductor system but shall be bonded into the LPS.
 - d. EC is responsible for all Surge Protection Device (SPD) requirements of the LPS. These devices shall be compliant for use with a lightning protection system by UL.

3.4 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presences of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductor with protective coatings where conditions cause deterioration or corrosion of conductors.

3.5 FIELD QUALITY CONTROL

- A. Obtain the services of Underwriters Laboratories, Inc. to provide inspection and certification of the lightning protection system under provisions of UL 96A.
- B. Obtain UL Master Label and deliver the UL Master Label Document to the Owner.
The UL Master Label is now an electronic document and is valid for only 5 years from date of issuance
- C. The grounding system shall be tested to meet 10 Ohms or less, using the fall of potential method. A written report, with the form being acceptable to the engineer, and meeting current industry standards, shall be submitted for project records. If the resistance is over 10 Ohms, the installing contractor shall test the soil resistance and calculate a method for obtaining the 10 Ohms or less to the engineer for review. The engineer will decide how to proceed.

END OF SECTION 26 41 13

SECTION 26 43 14 - SURGE PROTECTIVE DEVICE (SPD)

PART 1 - GENERAL

1.1 SUMMARY

- A. This specification includes requirements for a high energy, field-mounted, Surge Protective Device (SPD) Type 1 (formerly known as Secondary Surge Arrestor/TVSS) and SPD Type 2 (formerly known as Transient Voltage Surge Suppressor) electronic filtering system used to protect low-voltage AC electrical distribution from the effects of lightning, utility switching events, temporary over voltages (TOV), and impulses generated internally within a facility.

1.2 RELATED DOCUMENTS

- A. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:
 - 1. ANSI/IEEE C62.41.1-2002, C62.41.2-2002 and C62.45-2002
 - 2. Canadian Standards (CUL)
 - 3. Federal Information Processing Standards Publication 94 (FIPS PUB 94)
 - 4. National Fire Protection Association (NFPA 70 (NEC), 75 and 78)
 - 5. Underwriters Laboratories Listed (UL 96A, 198, 248-1, 489, 1283 and 1449-Third Edition)

1.3 SUBMITTALS

- A. Product Data: Provide complete product data detailing manufacturer's model number, specifications, features and options.
- B. Test Data: Manufacturers shall submit certified independent 3rd party test data verifying the following: life cycle testing, overcurrent protection, UL1449 Third edition as tested by Underwriters Laboratories (UL), noise attenuation and surge current capacity. Data shall include type classification (Type 1, Type 2), voltage protective rating (VPR), actual MCOV test value, nominal discharge current test (I_n) rating.
- C. Shop Drawings: Provide electrical and mechanical drawings that include detail on unit dimensions, weights, field connections and mounting provisions.
- D. Installation, Operation and Maintenance Manuals: Provide one copy of the installation, start-up, operation and maintenance data for each unit supplied.

1.4 ACCEPTABLE MANUFACTURER

- A. These specifications detail performance requirements for a surge suppression system manufactured by Current Technology, Citel (Panelboards only), Emerson/Liebert, Square D/Schneider, Eaton/Bussmann, General Electric, Mersen, Siemens or Thor. Substitute, value-engineered or alternate products shall meet all performance and reliability aspects of this specification, including the substitute/alternate products submittal requirements.

1.5 SUBSTITUTION PRE-APPROVAL PROCEDURES

- A. Manufacturers requesting approval of their products shall identify the full model number and submit product data and specifications.

1.6 WARRANTY

- A. The manufacturer shall provide a ten (10) year limited warranty for service entrance and switchboard units, and a ten (10) year limited warranty for panelboard units from the date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

1.7 LOCAL SERVICE SUPPORT

- A. A dedicated support organization shall be located within 150 miles of the project location, and shall have experience supporting at least twenty other projects of similar complexity within the last three years.

PART 2 - PRODUCTS

2.1 HIGH PERFORMANCE SUPPRESSION SYSTEM

- A. The suppression system shall incorporate metal oxide varistor (MOV) arrays and filtering capacitors. These components shall optimally share surge currents to ensure maximum performance and long-term reliability. The system shall not utilize gas tubes, spark gaps, silicon avalanche diodes, or other components that might short or crowbar the line, thus leading to power interruption.

2.2 UL 1449 THIRD EDITION UL TYPE 1 AND TYPE 2 DEVICE

- A. The unit shall be certified as a Type 1 or Type 2 device suitable for use in these applications. The nominal discharge current shall be 20 KA, and the applied MCOV value shall be the actual MCOV of the unit's suppression components (i.e., between 115% and 130% of nominal installed voltage, according to Section 2.4).

2.3 UNIT OPERATING VOLTAGE

- A. The operating voltage and configuration shall be 277/480-Volt or 120/208-Volt grounded wye as indicated on the drawings.

2.4 MAXIMUM CONTINUOUS OPERATING VOLTAGE (MCOV)

- A. The MCOV shall be greater than 115 percent (%) of nominal voltage, but no greater than 130 percent (%).

2.5 PROTECTION MODES

- A. All modes on all phases shall be protected (e.g., line-to-line, line-to-neutral, line-to-ground and neutral-to-ground).

2.6 RATED SINGLE PULSE SURGE CURRENT CAPACITY

- A. The proposed product shall be single pulsed surge current tested in all modes at the rated surge currents by an industry recognized independent test laboratory. The test shall include a surge impulse (6kV (1.2x50 μ s), 500 amp (8x20 μ s) waveform) to benchmark the unit's suppression voltage. The applied impulse is followed by a single pulse surge of the maximum rated surge current magnitude, followed by a second 6kV (1.2x50 μ s), 500 amp (8x20 μ s) impulse as a means of measuring clamping deviation (component degradation). Compliance is achieved if the two measured suppression voltage do not vary by more than 5%.

Rated Single Pulse Surge Current Capacity				
Location	L-N	L-G	N-G	L-L
Service Entrance & Switchboards	120,000 A	120,000 A	120,000 A	120,000 A
Panelboards	50,000 A	50,000 A	50,000 A	50,000 A

2.7 MINIMUM REPETITIVE SURGE CURRENT CAPACITY

- A. Per ANSI/IEEE C62.41 and ANSI/IEEE C62.45-2002, every mode of the suppression filter system shall be designed to survive multiple Category C 20 KV, 10 KA impulses. Test

documentation shall detail the unit's ability to survive the following number of events (at one minute intervals) without any performance degradation.

Repetitive Surge Current Capacity - Number of Impulses				
Locations	L-L	L-N	L-G	N-G
Service Entrance & Switchboards	>12,000	>12,000	>12,000	>12,000
Panelboards	>4500	>4500	>4500	>4500

2.8 HIGH FREQUENCY EXTENDED RANGE FILTER

- A. Noise Attenuation: The filter shall provide an attenuation of 63 db max from 10 kHz to 100MHz, per 50 Ohm Insertion Loss Methodology from MIL 220A. The system shall provide up to 120-dB insertion loss from 100 kHz to 100 MHz when used in a coordinated facility system
- B. For installations that install multiple downstream filters, the filters shall be coordinated to provide minimum noise rejection/attenuation as follows:
 - 1. NOTE: Insertion loss data shall be based on a minimum of 100 feet of #4 AWG conductor between filters.

2.9 UL 1449 THIRD EDITION VOLTAGE PROTECTIVE RATING

- A. The voltage protective rating (VPR) for grounded wye circuits at applicable voltage shall not exceed the following:

System Voltage	Mode	UL 1449 Third Edition VPR
120/208	Line to Line (L-L)	1200
	Line to Neutral (L-N)	700
	Line to Ground (L-G)	700
	Neutral to Ground (N-G)	700
277/480	Line to Line (L-L)	2000
	Line to Neutral (L-N)	1200
	Line to Ground (L-G)	1200
	Neutral to Ground (N-G)	1200

2.10 REDUNDANT OVERCURRENT PROTECTION

- A. Each suppression element shall utilize individual tested fuses to ensure that the failure of a single suppression component, or operation of any single fuse does not render the entire mode,

phase or product deficient by more than twenty percent (20%). All fuses shall be capable of withstanding the rated single pulse surge current capacity of the individual components they protect without failure.

2.11 INTERNAL CONNECTIONS

- A. Internal surge current paths shall utilize low-impedance copper bus bar. No plug-in modules or quick-disconnect terminals shall be used in the surge current-carrying paths.

2.12 ENCLOSURE

- A. The service entrance unit shall utilize a NEMA 1 metallic enclosure for interior locations.

2.13 ADDITIONAL FEATURES/EQUIPMENT

- A. Advanced Monitoring Feature. A battery-powered audible alarm with event counter display and two sets of form C dry contacts (N.O. or N.C.) shall be provided. The alarm shall indicate single or multiple phase failure of the filter.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The service entrance, switchboards, and panelboard filters shall be installed external to the switchgear/panelboard as close as possible to the connection point following the manufacturer's recommendations for conductor size and minimal bends. The SPD shall be independently immediately above the protected equipment and fed from a breaker mounted at the top of the bus.
- B. All insulation resistance tests shall be performed without being connected to the distribution equipment.

3.2 START UP SERVICES

- A. Complete start up checks according to manufacturer's written instructions.

3.3 EQUIPMENT MANUAL

- A. An equipment manual shall be provided that details installation, operation, and maintenance instructions for the filter. Information shall include unit dimensions, weights, mounting provisions, connection details and a layout diagram.

END OF SECTION 26 43 14

SECTION 26 50 00 - LIGHTING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including general and supplementary conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 26 Basic Electrical Materials and Methods sections apply to work specified in this section.
- C. Refer to Appendix "A" for Light Fixture Cutsheets and specification section 26 56 13 Poles and Standards.

1.2 SUMMARY

- A. Extent, Relative location, and details of lighting fixture work are indicated on drawings and in schedules. Refer to Architectural Reflected Ceiling (landscape Architect) Plans for precise fixture locations.
- B. Types of lighting fixtures in this section include the following:
 - 1. Incandescent.
 - 2. Light Emitting Diode, LED
 - 3. Other lamps as noted on fixture schedule.
- C. Fixture: A complete lighting unit Includes lamps, wiring, controls and parts required to securely support fixture.
- D. Exact ceiling construction shall be verified and coordinated with fixture type and mounting prior to ordering. Minor changes in ceiling construction shall not be an extra cost to the project.
 - 1. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this Specification shall be furnished by the Contractor.
 - 2. Specialty ceiling systems that require unique lighting fixtures tailored to a specific manufacturer's ceiling system shall be submitted with ceiling materials and layouts to ensure coordination and verification of ceiling details prior to ordering the light fixtures.
 - 3. Fixtures shall be manufactured in strict conformance with the Contract Drawings and Specifications.

4. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary of the work.
 5. Minor details, not usually indicated on the drawings nor specified, but that are necessary for the proper execution and completion of the fixtures, shall be included, the same as if they were herein specified or indicated on the drawings.
 6. The Owner shall not be held responsible for the omission or absence of any detail, construction feature, etc., which may be required in the production of the fixtures. The responsibility of accurately fabricating the fixtures to the fulfillment of this specification rests with the Contractor.
- E. Where a catalog number and a narrative or pictorial description is provided, the written description shall take precedence and prevail.
- F. General Contractor shall provide electrical subcontractor with entire lighting specification (including fixture cut sheets, illustrations and sketches); electrical subcontractor shall provide each specified manufacturer with complete information about the fixtures they will supply.
- G. The contractor shall include the installation of an additional 30 exit signs in the base price for future request for exit signs by the Fire Department or Building Official. This quantity shall apply to all base area projects associated with Phase 1 (Summer 2021) construction.
- H. Fixture details shown may be modified by the manufacturer provided all of the following conditions have been met:
1. Fixture performance is equal or improved.
 2. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved.
 3. Cost to the Owner is reduced or equal.
 4. Modifications have been reviewed by the Architect and have been approved by the Architect in writing.

1.3 SUBMITTALS

Submit shop drawings, samples, and prototypes as specifically instructed below.

- A. Shop drawings shall include but not be limited to:
1. For standard catalog items with no modifications, submit catalog cut sheets prepared by the manufacturer which clearly show all elements to be supplied and all corresponding product data (including lamping; ballast manufacturer and model number; voltage; accessories or options and any miscellaneous items detailed in the written description of the specification). If cut sheet shows more than one (1) fixture type, all non-applicable information shall be crossed out.
 2. For lamps, submit catalog cut sheets prepared by the manufacturer which clearly shows manufacturer, CRI, CT, wattage, base type, lumen output, lamp life, and any other pertinent information.

3. For custom fixtures, modified fixtures or linear fixtures mounted in continuous rows, submit a reproducible drawing prepared by the manufacturer showing all details of construction, lengths of runs, lamp source type and location, pendant locations, power locations, finishes and list of materials. Drawings must be to scale. Contractor shall provide manufacturer with field dimensions where required. Should these custom/modified fixtures be specific to a manufacturer's ceiling system, provide both the fixture submittal and the ceiling submittal simultaneously.
4. For all submittals under paragraphs 1 through 3 above, manufacturer shall provide submittals within two weeks of receipt of order. All submittals shall have project name and fixture type clearly shown.
5. The Architect/Engineer shall make the final determination as to whether or not the submittal contains sufficient information and reserves the right to request a shop drawing if the fixture cut is insufficient.
6. Maintenance Data: Submit maintenance data and parts list for each lighting fixture, accessory and also include "trouble-shooting" maintenance guide. In addition to the product data and shop drawings, a maintenance manual in accordance with general requirements of Division 1 shall be provided.

B. Samples:

1. It shall be the responsibility of the Contractor to provide a sample(s) fixture when requested or as stated herein. A minimum of (5) samples are anticipated. When samples are called for the manufacturer shall provide one working samples, unless otherwise noted, complete with lamp, ballast (rated for 120-Volt operation) and 6' pig-tail 3-prong Edison plug.
2. The sample(s) shall be shipped to a location that is determined by the Architect. Shipping and return shipping costs shall be provided as part of the contract.
3. The purpose of the sample is to review manufacturing techniques, detailing, lamping and scale. Sample fixtures must be approved prior to fabrication of fixtures for the project. Minor modifications, if any, shall be considered part of these Specifications and shall be accomplished with no additional cost to the Owner.
4. Sample fixtures may not be used on the project.
5. In the event the submissions are disapproved, the fixtures will be returned to the contractor to immediately make a new submission of fixture or fixtures meeting the contract requirements.
6. All costs associated for samples are to be paid by the Contractor. No additional costs to the Owner for samples or mockups will be allowed.

C. Shop drawings and samples requested shall be submitted for approval before fabrication. Any material produced prior to the approval of shop drawings or samples, and not in conformance with the Contract Documents, shall be disapproved with the Contractor bearing full responsibility and cost.

D. No variation from the general arrangement and details indicated on the drawings shall be made on the shop drawings unless required to suit the actual conditions on the premises, and then only with the written acceptance of the Architect. All variations must be clearly marked as such on the drawings submitted for approval.

E. Mock-ups:

1. Mock-Up General Requirements

- a. It shall be the responsibility of the Contractor to provide a mock-up of the lighting fixture or lighting systems as indicated in the fixture descriptions or as requested by the lighting designer or engineer. The mock-up shall be erected within a time period and in a location that is acceptable to the Architect. A minimum of five (2) additional mock-ups are anticipated and will be coordinated with the construction team at a later date.
- b. The mock-up installation shall closely conform to the conditions of the actual installation as to: height, distance from ceiling, number and type of lamps, material, color and etc. The Contractor shall submit a written description of each proposed mock-up with drawings in order to obtain the Architect's approval prior to commencement of each mock-up.
- c. The purpose of the mock-up will be to study the general appearance and performance of the intended lighting systems. At that time, certain minimal test variations may be requested as to lamp location, lamp type, reflector shape, color and etc. Final modifications, if any, shall be considered a part of these Specifications and shall be accomplished with no additional cost to the Owner.

2. Mock-Up Description:

- a. Type S2 step light installed in stone wall at stairs.
 - 1) Provide 3' wall section to match final condition with 1 step light installed in the center of the wall section.
- b. Type F6 in Art Wall cabinet at Gold Walk.
 - 1) Provide (3) sections of the Art Wall as indicated per plan that may be installed in place and mocked up for final install pending final comments are reviewed and incorporated to this section as well as the rest of the Art Wall. This will give the design team a chance to review the lights prior to completion of the art wall in an incorrect manner.
- c. Type F8 String lights in trees.
 - 1) Provide mock-up at similar location in the base area with driver, driver enclosure, string lights installed within tree.

F. Wiring Diagrams – as needed for special operation or interaction with other system(s).

G. Substitutions: Manufacturers or light fixtures not listed on fixture schedule must be prequalified prior to bid. This is demonstrated by an "Approved Alternate" listing in the manufacturer column. It in no way implies approval. For approval of all manufacturer/fixture substitutions,

the bidders shall comply to specifications herein and as outlined below for submitting alternate fixtures:

1. No substitutions shall be accepted when the LIGHT FIXTURE SCHEDULE includes a three-name manufacturer specification.
2. Should only one manufacturer be listed, with no "Approved alternate" statement, no substitutions are allowed.
3. Light fixture bids must be priced separately and shall not be bundled with any other material or product bids, including but not limited to lighting control devices and lighting control systems.
4. Manufacturer shall have not less than five years of experience in design and manufacture of lighting fixtures of the type and quality shown. Prequalification submissions must include a list of completed projects and data catalogue pages and drawings indicating length of experience.
5. Bidders wishing to obtain approval on brands other than those specified by name and catalog number or as an approved alternate in LIGHTING FIXTURE SCHEDULE shall submit their requests not later than fifteen (15) business days before the bid opening. Approval will be in the form of an addendum to the specifications issued to all prospective bidders indicating that the additional brand or brands are approved, as equal to those specified as far as the requirements of the project are concerned.
6. If the bidders do not elect to obtain prior approval during the time so specified above, the Owner/Architect/Engineer or Lighting Designer has no obligation to review or consider any such article after the contract award.
7. Contractor shall pay professional fees at current standard hourly rates and reimburse expenses directly to all designers (Architect, Engineer and Lighting Designer) for time spent reviewing substitutions proposed by the Contractor after the bid has been awarded. If payment by the Contractor is not made within 60 days of invoice date, the Owner shall deduct the amount due from subsequent payments to the Contractor in order to reimburse designers.
8. Request for approval shall be accompanied by working fixture samples (with an appropriate lamp, complete photometric, mechanical and electrical data, list of materials and finishes and unit cost to the Owner) of both the specified brand and the proposed substitutes as required to make complete comparison and evaluation. These samples shall be in addition to those required by Lighting Fixture Specification. The above data shall be delivered separately to the Architect and the Engineer. The fixture samples shall be furnished and installed at the bidder's expense, at a location selected by the Architect. In addition, the bidder shall furnish the Architect and the Engineer with the name and location of at least one completed project where each proposed substitute has been in operation for a period of at least six (6) months, as well as the names and addresses of the Owner, the Architect and the Engineer.
9. Point by point lighting calculations of areas affected by proposed substitution will be done by the bidder for review.
10. The Architect and Engineer shall determine whether the prototype sample complies with the specifications and shall reserve the right to disqualify any bidders.
11. When required and requested by the Architect, or Engineer, samples submitted as per above shall be subjected to photometric, thermal, mechanical, electrical or water testing at an independent test laboratory at no expense to the Owner.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of lighting fixtures of sizes, types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firms with at least 5 years of successful installation experience on projects with lighting fixture work similar to that required for this project.
- C. Codes and Standards:
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 220, 225, 250, 410, and 500 as applicable to installation and construction of building lighting fixtures.
 - 2. NEMA Compliance: Comply with applicable requirements of NEMA Standards Pub/No's LE 1 and LE 2 pertaining to lighting equipment.
 - 3. IES Compliance: Comply with IES RP-1 pertaining to office lighting practices and RP-15, regarding selection of illuminance values for interior office lighting. Comply with IES RP-8, 19, 20, and PB-15 pertaining to exterior, parking, and roadway lighting practices and fixtures.
 - 4. UL Compliance: Comply with UL standards, including UL 486A and 486B, pertaining to lighting fixtures. Provide lighting fixtures and components which are UL-listed or ETL listed and labeled.
 - 5. American National Standards Institute (ANSI)
 - a. ANSI C82.11 – Performance requirement for high frequency ballasts
 - b. ANSI/IES RP-16-10 – Nomenclature and definitions for illuminating engineering
 - c. ANSI E1.20 - Remote Device Management Over DMX512 Networks
 - d. ANSI C62.41 – Recommended practice in low power circuits
 - 6. International Electrotechnical Commission (IEC).
 - a. IEC 61347-1 – General and safety requirements for lamp control gear
 - b. IEC 61347-2-13 – Particular requirements for electronic control gear for LED modules
 - c. IEC 62384 - DC or AC supplied electronic control gear for LED modules – performance requirements
 - d. IEC 61000-3-2 - Harmonic current emissions
 - e. IEC 61547 - EMC immunity requirements
 - f. IEC 62386-101/102/207 – Digital addressable lighting interface (DALI)
 - 7. European Mark for electrotechnical products (ENEC)
 - a. EN55015 – Radio disturbances <30 Mhz
 - b. EN55022 – Performance requirement for EMC, Information technology and Telecommunications equip.

- c. EN60929/IEC60929 – Performance requirement for AC supplied electronic equipment
- 8. Federal Communications Commission (FCC) rules – Part 15 Class B: Radio Frequency Devices.
 - a. Commercial rated
- 9. Entertainment Services and Technology Association
 - a. ESTA E1.3 - Entertainment Technology - Lighting Control System - 0 to 10V Analog Control Protocol
- D. Special Listing and Labeling: Provide fixture for damp locations, wet locations, recessed in rated ceilings and walls, hazardous that are UL listed and labeled for specific use.
- E. Fixtures mounted within air plenum spaces shall meet National Electrical Code, Building Code and NFPA definitions and requirements for equipment installed in plenum spaces. Assume all interior fixtures recessed mounted in or above ceilings or mounted in coves, shall be required to be suitable for use in plenums.
- F. Materials and Equipment:
 - 1. Materials, equipment, and appurtenances as well as workmanship provided under this Section shall conform to the highest commercial standards, and as specified and as indicated on drawings. Fixture parts and components not specifically identified or indicated shall be made of materials most appropriate to their use or function and as such resistant to corrosion and thermal and mechanical stresses encountered in the normal application and function of the fixtures.
 - 2. All fixtures shall be manufactured to a consistent level of quality. Size, color, and component parts shall be identical for all fixtures of the same type.
- G. Manufacturer: Minimum 5 years of experience in manufacture of dimmable electronic lighting drivers.
- H. Recognized by UL for use in the US and Canada. Provide evidence of compliance upon request.

1.5 DELIVERY, STORAGE, HANDLING, AND WARRANTY

- A. Deliver lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from damage.
- B. Store lighting fixtures in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperature, humidity, laid flat and blocking off ground.

- C. Handle lighting fixtures carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.
- D. Provide a 5-year warranty of failure in materials, workmanship, ballast, driver, etc., in addition to and not limited to other rights the Owner may have under the contract documents. A full warranty shall apply for the first year, and a prorated warranty for the last four years.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate with other work including wires/cables, electrical boxes and fittings, and raceways to properly interface installation of lighting fixtures with ceiling requirements.
- B. Sequence lighting installation with other work to minimize possibility of damage and soiling during remainder of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The Contractor shall base bid for lighting fixtures on the manufacturers listed on the fixture schedule only.
- B. Alternate manufacturer's identification by means of manufacturer's names is to establish basic features and performance standards. Alternate manufacturers or substitutions must meet or exceed the standards of the primary manufacturer listed.
- C. Qualifications: The contractor is allowed 60 days after the contract has been awarded to submit independent photometric tests and samples for all approved alternate fixtures. If these fixtures fail to comply with the specification requirements at that time, the Contractor will furnish acceptable fixtures at no additional cost to the Owner and with no delay to the project.
- D. Any submittals for cost reduction alternates or value engineering shall include unit prices for the specified manufacturer, the specified equal manufacturer, and the proposed alternates. Refer to Part 1.3 for approval process.

2.2 FIXTURES MODIFICATIONS

- A. the Contractor shall supply the project with fixtures to be modified by the Manufacturer as required by the Project Fixture Schedule, Fixture Cuts, or drawings.
- B. Modified fixtures include, but are not necessarily limited to Type F4 (catenary mount) and Type F7 (mounting bracket).

2.3 FINISHES

- A. Fixture finishes shall be applied in a manner that will assure a durable, wear resistant surface.
1. Prior to finishing, all surfaces shall be free from foreign materials such as dirt, rust, oil, polishing compounds and mold release agents.
 2. Where necessary, surfaces shall be hot cleaned by accepted chemical means and shall receive corrosion inhibiting (phosphating) treatment assuring positive paint adhesion.
 3. Provide all ferrous metal surfaces with a protective finish having rest-inhibiting properties. Painted finishes shall be a minimum of 1.5 mils thick and shall have a balance between hardness and bending properties suitable for application. White finishes shall have 87 percent minimum reflectance. Application and cleaning shall be performed so as to prevent any loss of reflectance capability.

2.4 WIRING

- A. All wiring shall comply with the following:
1. All wiring devices within lighting fixtures or from the fixture to the splice with the project branch circuit wiring shall be as specified below.
 2. Wiring shall be protected with tape or tubing at all points where abrasion may occur.
 3. Wiring shall be concealed within the fixture construction except where design or mounting dictates otherwise.
 4. Connections of wires to terminals of lampholders and other accessories shall be made in a neat and workmanlike manner and electrically and mechanically secure with no protruding or loose strands. The number of wires extending to or from the terminals of a lampholder or other accessory shall not exceed the number which the accessory is designed to accommodate.
 5. Joints in wiring within lighting fixtures and connections of the fixture wiring to the wiring of the building shall be specified in Division 26.
 6. Wiring channels and wireways shall be free from projections and rough or sharp edges throughout, and all points or edges over which conductors must pass and may be subject to injury or wear shall be rounded and bushed.
 7. Insulated bushings shall be installed at points of entrance and exit of flexible wiring.
 8. Junction boxes attached to lighting fixtures shall be manufactured in accordance with the National Electrical Code and approved for the number of conductors indicated on the drawings. Supplementary junction boxes shall be installed where required to comply with Code.
 9. When exposed, all junction boxes and conduit to be painted as per the Architects' direction at no additional cost to the Owner.
 10. Cord types shall be suitable for application and be fitted with proper strain relief and watertight entries where required by application.
 11. Furnish code approved wiring in ceiling cavities forming air plenums. Wiring and raceway installed in plenums shall be suitable for plenum use. All interior lighting raceway shall be suitable for plenum use.

2.5 MARKING OF FIXTURES

- A. Fixtures designed for voltages other than 110-125-Volts shall be marked with operating voltage.
- B. Fixtures equipped for operation of rapid start lamps shall be clearly marked "USE RAPID START LAMPS ONLY."
- C. Fixtures designed for operation of lamps below the rated enclosure maximum shall be clearly marked "Lamp Watts Not to Exceed _____" to maintain the design energy load.

2.6 THERMAL PROTECTORS

- A. Provide thermal protectors as required by the N.E.C., or as required by local Code, to prevent operation of lighting fixtures in enclosed spaces or adjacent to combustible materials at temperatures at or above 90°C (194°F).
- B. Fixtures approved for operation in fire-resistant material at temperatures up to 150°C (302°F) shall be plainly marked.
- C. All incandescent fixtures shall be provided with thermal protectors except where otherwise indicated or where approved for operation without such protectors by the N.E.C. and by the local building authority.

2.7 LAMPS

- A. Provide lamps as shown in the fixture schedule or as modified in reviewed shop drawings.
- B. Lamps as specified for the individual luminaries or lighting equipment shall be delivered and installed in fixtures and lighting equipment leaving these completely lamped and in normal operating condition.
- C. Provide all incandescent lamps inside frosted, unless noted otherwise. Refer to light fixture schedule for details.
- D. LED lamp sources shall conform to the IESNA LM-79 and LM-80 published standards. They shall have a color temperature binning that does not exceed +/-200K. LED Lamp life shall be rated at 70% of initial lumens remaining. LED drivers shall be used @ 100% output for lumen output rating and not be underdriven or overdriven.
- E. Lamps shall be by the same manufacturer and produced by the following acceptable manufacturers:
 - 1. General Electric Lighting
 - 2. Osram Sylvania, Inc.

3. North American Philips Lighting
4. Venture Lighting International, Inc.
5. Others only where specified.

2.8 LAMPHOLDERS

- A. Lamp sockets shall be rigidly attached to fixture enclosure or housing.
- B. Incandescent lamp sockets shall be made of heavy-duty heat-resistant porcelain.
- C. Provide nickel plated brass or nickel and silver plated contacts in all lampholders for tungsten halogen lamps, lamps in outdoor fixtures, and mogul base incandescent.
- D. All lamp sockets shall be suitable for the indicated lamps and shall be set so that lamps are positioned in optically correct relation to all lighting fixture components. All adjustable sockets shall be preset at the factory for lamp specified.

2.9 LIGHT EMITTING DIODE (LED)

- A. All LED light fixtures shall conform to the IESNA LM-79 and LM-80 published standards.
- B. Initial delivered lumens – thermal losses should be less than 10% when operated at a steady state at an average ambient operating temperature of 25°C, and optical losses should be less than 15%.
- C. Average Delivered Lumens – Average delivered lumens over 50,000 hours should be minimum of 85% of initial delivered lumens.
- D. LED boards, drivers and associated components shall have a Warranty of 5 years on the LEDs, 5 years on the driver, 5 years on the paint finish.
- E. LED Power Supply
 1. Power supplies shall meet or exceed the technical and performance standard all power supplies shall meet or exceed the following basis:
 - a. The LED power supply shall accept an input voltage range of 120-277VAC +/- 10%
 - b. The LED power supply shall have a power factor of 0.9 or higher
 - c. The LED power supply shall have a maximum THD of 20% at full load (@ 120V or 277V)
 - d. The minimum efficiency of the LED power supply shall be 85% at full load

- e. Control Input
 - 1) Power supplies with dimmable outputs shall indicate whether the output is Pulse Width Modulated (PWM), Constant Current Reduction (CCR), or a combination. For PWM dimming, the frequency shall be >1000hz to minimize risks of strobe effect.
 - 2) Phase control
 - a) Dimming of the input power source down to 1% of the power supply output. It shall be the responsibility of the installing contractor to coordinate phase control dimming technology with the lighting control devices.
- f. Phase-controlled power supply shall indicate the preferred method of phase-controlled input (forward or reverse)
 - 1) 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
 - a) Compatible with Passive or solid state current sink devices down to 1% of the power supply output
 - b) The 0-10VDC dimming circuit shall not exceed 15V DC in an unloaded or loaded condition.
 - c) Must meet IEC 60929 Annex E for General White Lighting LED drivers
 - d) Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 mA per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
 - e) Must meet ESTA E1.3 for RGBW LED drivers
 - f) Interface with 0-10 dimming driver shall be completely isolated from AC power to prevent AC voltage on the 0-10V wires.
 - g) The available sink current from each driver on the 0-10V interface shall not exceed 1 mA.
 - 2) Digital (DALI Low-Voltage Controlled) Dimming Drivers
 - a) Must meet IEC 62386
 - 3) Digital Multiplex (DMX Low-Voltage Controlled) Dimming Drivers
 - a) Must meet DMX / RDM: USITT DMX512A and ANSI E1.20 (Explore & Address)
 - b) Capable of signal interpolation and smoothing of color and intensity transitions
- g. The LED power supply shall comply with FCC Part 15 (Class A or Class B)
- h. The LED power supply shall have a Class A sound rating.

- i. The LED power supply shall have two cycle inrush current when power is applied that does not exceed 20 times steady state current per power supply.
- j. Total Harmonic Distortion less than 20% percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.
- k. The LED power supply shall have transient protection – ANSI C62.41 Category A
- l. The LED power supply shall be UL 8750 Class 2 Recognized or Listed, Damp rated.
- m. The LED power supply output voltage should not exceed 60V (Complies with Class 2 for US)
- n. Driver should be UL Recognized under the component program and shall be modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.
- o. The LED Power supply shall have a minimum of 50,000 hours of rated lifetime at maximum operating conditions.
- p. The LED Power supply shall have a minimum of 5-year warranty Tc of 75C or higher point.

2.10 TRANSFORMERS (COLD CATHODE, NEON)

- A. All transformers shall be sized to accommodate the intended load and utilized to operate lamps in a method approved by Underwriter's Laboratory and acceptable by code and shall not exceed the following:
 - 1. Neon: 9,000-Volts, 30 ma.
 - 2. Cold Cathode: 150 ma.
- B. Transformers for non-dimming installations shall be high power factor type, voltage as specified in LIGHTING FIXTURE SCHEDULE. Transformers for dimming installations shall be 120-Volt, 60 hertz, low (normal) power factor type. Fixture manufacturer shall confirm compatibility of transformer with dimming system manufacturer. Secondary voltage shall be as required by lamp footage, cold weather usage and dimming. Transformers shall be UL listed, self-contained steel enclosure equipped with a disconnect switch which shall automatically disconnect the primary when the wiring compartment cover is removed. Transformers shall be installed in accessible and ventilated area (100°F maximum ambient temperature) with air circulation on all sides to dissipate full wattage rating of the transformer. Each transformer shall be installed as close to the lamp as possible in order to keep the secondary feeds as short and equal in length as possible. Wiring compartments shall be accessible if mounted above ceilings, in partitions, or in any location other than electrical closets.
- C. Provide self-contained, U.L. listed transformers in 16-gauge steel housing with secondary and primary wiring compartments, mount all transformers securely to the fixture housings (if integral) or to the building structure (if remote) with neoprene pads to isolate vibration and noise.

- D. Provide all transformers with secondary overcurrent protection and a primary disconnect switch, which will automatically disconnect the primary switch when the wiring compartment cover is removed.
- E. All transformers shall be installed in an accessible and ventilated location with a maximum 100°F, ambient temperature with air circulation on all sides.
- F. All winding type transformers will be high power with a maximum crest factor of 1.6.
- G. All regulating transformers shall be tested to have an output regulated to +/-3 percent for input variations of 15 percent to 25 percent, less than 3 percent distortion with a minimum load efficiency of 85 percent, and operating temperature of -20°C to 70°C.

2.11 REFLECTORS

- A. Reflectors and reflecting cones or baffles shall be as follows:
 - 1. Absolutely free of any tooling marks including spinning lines, indentations caused by riveting or other assembly techniques.
 - 2. No rivets, springs, or other hardware visible after installation.
 - 3. First quality polished, buffed and anodized finish, "Alzak" or approved equal.
 - 4. Specular finish color as selected by the Architect or as specified in the fixture schedule.
- B. Other aluminum reflectors shall be as follows:
 - 1. Formed and finished as noted on the Drawings and elsewhere in the Specification.
 - 2. Reflectors free from blemishes, scratches, or indentations which would distort their reflective function.
 - 3. Finished by means of the "Alzak" process or approved equal unless otherwise noted.
- C. Reflector and housing shall comply completely enclose the fixture's source in downlights in a plenum ceiling and provide the full rated output of the lamp. Fixtures that vent through the downlight reflector into the plenum are not acceptable.

2.12 LENSES

- A. All lenses secured by positive means with neoprene or silicone gasketing or washers as required to hold the lens tight within a frame or attach to housing.
- B. All glass lenses shall be heat treated (tempered) or sealed with a clear acrylic laminate layer to provide a "safety glass" rating. All lenses which require removal for relamping or normal maintenance shall be attached to the fixture housing by a minimal length of safety chain to prohibit the lens from falling and striking surrounding surfaces.

- C. Acrylic lenses shall be 100 percent virgin acrylic polymer and colorless. For lenses with pattern of pyramids or cones, specified minimum thickness refers to distance from flat surface to base of pyramids (cones), or thickness of undisturbed material. All lenses shall be a minimum .156" thick.
- D. The quality of the raw acrylic material must exceed IES, SPI, and NEMA Specifications by at least 100 percent which, as a minimum standard, shall not exceed yellowness factor of 3 after 2,000 hours of exposure in the Fade-o-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.

2.13 LOUVERS

- A. All louvers shall be fabricated of the specified material.
- B. Louver finishes shall be provided as specified.
- C. All plastic parabolic louvers shall be destaticized before and after fabrication to insure minimum maintenance.
- D. All metal louvers shall be coated with anti-rust material and electrostatically painted.
- E. All louvers shall be heat tested to withstand lamp operating temperatures with no deformation of shape, paint blistering or discoloration.

2.14 FIXTURE TRIMS

- A. Fixtures shall have finish trim designed for the following types of ceiling systems: Ceiling Type Trim Type
 - 1. Recessed Incandescent or LED
 - a. Plaster - Overlap Trim.
 - b. Concrete - Overlap Trim.
 - c. Tile - Overlap Trim.
 - d. Gypsum - Overlap Trim.
 - e. Metal Pan, Concealed M - Modular, Fit-in Support.
 - f. Lay-in - Modular, Tile with Flush Fit-in.
- B. Provide trim details as shown on the Drawings or as specified, which are indicative of appearance and dimensional requirements. The trim finish and dimensions subject to the approval of the Architect.

- C. Trimless fixtures shall be installed per manufacture's guidelines and shall be installed and coordinated with other trades as required.
- D. Mitered corners shall be continuously welded and smoothed before shop finish is applied. No lapping of trim metal for all flush-mounted ceiling trims for rectangular or square recessed fixtures.
- E. Provide a mounting frame or ring with lock recessed or semi-recessed light fixture to secure the mounting frame to the ceiling and support any reflectors, trims, or lenses. Ring shall be compatible with the ceiling and of sufficient strength to rigidly support the fixture and any stress applied in relamping.
- F. Catalog numbers are included in the Lighting Fixture Schedule for reference. Provide all accessories and design features described herein regardless of whether such features are included in catalog reference including, mounting hardware, louvers, lenses, filters, transformers, etc.

2.15 LIGHTING FIXTURE TYPES AND CATALOG NUMBERS

- A. General: Various fixture types required are indicated on Lighting Drawing Fixture Schedule. Fixtures must comply with minimum requirements as stated herein. Review architectural drawings and specifications to verify and coordinate ceiling types, modules, suspension systems appropriate to installation.

2.16 AUXILIARY SUPPORTS FOR SUSPENDED FIXTURES

- A. Provide separate and isolated suspension for all fixtures required by code and seismic requirements. This includes rod hangers, hook hangers, or single stem hangers.

2.17 EMERGENCY LIGHTING UNITS

- A. Provide 90-minute battery pack emergency lighting fixtures with two lamp heads for all mechanical equipment rooms, electrical equipment room, generator area, etc. Battery units shall be self-contained, self-diagnostic, sealed, maintenance free, lead-acid type with 10-year normal life warranty.
- B. Provide continuous current carrying conductor from power source to emergency battery. Conductor shall be connected ahead of any switching conductors.
- C. Light produced by these emergency fixtures shall provide one foot-candle maintained have chargers and wire guards.

- D. All Exit signs shall come complete with mounting hardware directional chevrons, mirrored backing and graphics. Single face exit signs shall be constructed so they can be read from only the path of egress side.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which lighting fixtures are to be installed, and associated substrate for supporting lighting fixtures. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.2 INSTALLATION OF LIGHTING FIXTURES

- A. Contractor to coordinate exact quantities and critical dimension with field conditions.
- B. Contractor to verify and coordinate that appropriate framing, support structures, mounting brackets, and other required structural connections are provided by the General Contractor or other trades to insure a timely, correct and neat installation of all luminaries.
- C. Contractor to coordinate and provide any associated mounting hardware, conduit connections, or associated appurtenances to effectively install the luminaries. Provide each light fixture with complete installation instructions. All light fixtures to be installed in strict conformance with manufacturer's recommendations and instructions.
- D. Install lighting fixtures in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- E. Exact locations of all lighting fixtures including mounting heights and plan dimensions are as per the Architectural and/or Landscape Drawings. Any ambiguities or conflicts in this dimensional information to be identified to the Architect prior to installation.
- F. Provide fixtures and/or fixture outlet boxes with hangers to properly support fixture weight. Submit design of hangers, method of fastening, other than specified herein, for review by Architect.
- G. Install flush-mounted fixtures properly to eliminate light leakage between fixture frame and finished surface.
- H. Provide plaster frames for recessed fixtures installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.

- I. Fasten fixtures securely to structural supports, and ensure that pendant fixtures are plumb and level. Provide individually mounted pendant (cable or rigid stem), fixtures longer than an overall length of 2 feet with diagonal corrosion resistant aircraft cable bracing to minimize sway. Provide rigid stem hanger with ball aligners and provisions for minimum one-inch vertical adjustment. Mount continuous rows of fixtures with an additional stem hanger greater than number of fixtures in the row.
- J. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified on UL Standards. 486A and 486B and the National Electrical Code.
- K. Support pendant-mounted fixtures greater than an overall 2 feet in length at a point in addition to the outlet box fixtures stud with an appropriate safety cable. Certain decorative pendant fixtures may not require a safety cable, verify with Architect, Engineer or Lighting Designer.
- L. Fasten electrical lighting fixtures and brackets securely to indicate structural supports, including poles/standards, and ensure that installed fixtures are plum and level.
- M. Rigidly align all continuous rows of fixtures for true in-line appearance.
- N. Do not install exposed fixtures, reflectors or trims until all plastering and painting that may mar fixture finish is completed. Replace blemished, dented, damaged or unsatisfactory fixtures as directed.
- O. Support all fixtures independent of suspended ceiling, ductwork or piping.

3.3 FIELD QUALITY CONTROL

- A. Replace defective and burned out lamps for 3 months following the Date of Substantial Completion.
- B. At Date of Substantial Completion, replace lamps in lighting fixtures which have been operational over 400 hours and have a lamp life of less than 4,000 hours.
 - 1. Refer to Division 1 sections for the replacement/restoration of lamps in lighting fixtures, where used for temporary lighting prior to Date of Substantial Completion.
- C. Refer to Lighting Fixture Schedule for Attic Stock Requirements. Deliver replacement stock as directed to Owner's storage space.

3.4 AIMING AND ADJUSTMENT

- A. All adjustable lighting units shall be aimed, focused, locked, etc., by the Contractor under observation of the Architect, Engineer and/or Lighting Designer. It is the responsibility of the Contractor that all fixtures scheduled for aiming shall be operational prior to the aim work session. All aiming and adjusting shall be carried out after the entire installation is complete. All ladders, scaffolds, etc., required shall be furnished by the Contractor. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely. The aiming and adjustment of luminaires must take place after the project's amenities have been completely installed. These amenities shall include but are not limited to plantings, furniture, artwork, graphics and signage.
- B. Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing, aiming shall be accomplished at night.
- C. Lighting levels and Lighting Scenes shall be set by the Contractor as directed by the Architect, Engineer, or Lighting Designer. All exterior work and a significant amount of the interior work during these sessions will be done at night.
 - 1. It is the responsibility of the Contractor to have all fixtures and control systems operational prior to the level setting work sessions. The contractor will provide a factory technician from the specified Controls Manufacturer who will be present during all of the light level setting sessions to program the desired settings and scenes, as well as to instruct the Owner's maintenance staff in how to operate and program the control systems.
 - 2. The Contractor is responsible for scheduling the light level adjustment and aiming sessions. Aiming will be required first and immediately following will be light level adjustments.
 - 3. Three months after completion of the Project, the Control Manufacturer's factory technician will revisit the site and readjust light levels and scenes as requested by the Owner or Design Team. This visit will be coordinated and paid for by the Contractor as part of this contract.

3.5 CLEANUP

- A. Clean lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses. Two weeks prior to substantial completion, re-clean all fixtures for dust, fingerprints, and smudges from all visible parts of the fixture.
- B. Protect installed fixtures from damage during remainder of construction period.
- C. At the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturers, all broken parts shall have been replaced, and all lamps shall be operative.

3.6 GROUNDING

- A. Provide equipment grounding connections for lighting fixtures as indicating. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

3.7 DEMONSTRATION

- A. Upon completion of installation of lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION 26 50 00

SECTION 26 56 13 - POLES AND STANDARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

- A. The section includes but is not limited to erecting, trenching and installation of poles and standards.
- B. Applications of lighting poles and standards specified in this section include the following:
 - 1. Automobile parking lots.
 - 2. Pedestrian walkways and plazas.
 - 3. Building entrances.
- C. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Division 31 Section, "Earthwork" for excavation and backfilling of poles, standards, and foundations are specified in Division 2.
 - 2. Division 3 Section, "Concrete" for embedding poles, and for pole foundations.
 - 3. Wires/cables, raceways, and electrical boxes and fittings which are required in connection with electrical poles and standards are specified in Division 26.
 - 4. Exterior lighting fixtures (luminaries) and brackets which are required in connection with electrical poles and standards are specified in another Division 26 section, "Lighting Fixtures". For additional information refer to Appendix A – Lighting Fixture Cut Sheets for exact fixture specifics.

1.3 SUBMITTALS

Submit shop drawings, samples, and prototypes as specifically instructed herein and as follows:

- A. Shop drawings shall include but not be limited to:
 - 1. Submit fixture shop drawings in booklet form with a separate sheet for each fixture, assembled in “luminaire type” alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet.
 - 2. Manufacturer’s dimensioned scale drawings showing in complete detail, the fabrication of all electrical pole standards, arms, and hardware including overall and detail dimensions, finishes, metal thickness, type, fabrication methods, support method, ballasts, hinges, gaskets, wind loading, wire/cable connections, and all other information to show compliance with the Contract Documents.
- B. Samples
 - 1. Partial pole standards samples may be requested for any or all of the fixtures specified.
 - 2. Submit for approval samples called for by the Engineer when and where directed, and the components tagged with the name of the project. Samples will not be returned. Allow two weeks from the date of receipt for thorough examination and review by the Architect and Engineer.
 - 3. All samples require a submission of material finish samples and component approval to be reviewed prior to shipment of any material to the project.
 - 4. Electrical pole standards under the contract shall be identical with the approved sample. No portions or parts of the electrical pole standard used as a sample will be allowed to be installed on the project.
 - 5. In the event the submissions are disapproved, the samples will be returned to the Contractor to immediately make a new submission of electrical pole standards meeting the contract requirements.
 - 6. All costs associated for samples are to be paid by the Contractor. No additional cost to the owner for samples will be allowed.
- C. Wiring Diagrams: Submit wiring diagrams for electrical poles and standards showing connections to electrical power panel feeders, switches, and controllers. Differentiate between portions of electrical wiring which are manufacturer-installed and portions which are field-installed.
- D. Shop drawings and samples requested shall be submitted for approval before fabrication. Any material produced prior to the approval of shop drawings or samples, and not in conformance with the Contract Documents, shall be disapproved with the Contractor bearing full responsibility and cost.
- E. No variation from the general arrangement and details indicated on the drawings shall be made on the shop drawings unless required to suit the actual conditions on the premises, and then only with the written acceptance of the Architect. All variations must be clearly marked as such on the drawings submitted for approval.

- F. Manufacturers not listed must be pre-qualified prior to bid. For approval of all electrical pole standards substitutions, the fabricator shall comply to specifications herein and as outlined below:
1. Manufacturer shall have not less than 5 years experience in design and manufacture of pole standards on the type and quality shown. Pre-qualification submissions must include a list of completed projects and dated catalogue pages and drawings indicating length of experience.
 2. Manufacturer shall also submit a partial prototype sample of each pole standard for review by the Architect and Engineer. Prototype samples shall be sufficiently detailed to allow evaluation of compliance with the salient features of the specification. Preliminary design or shop drawings shall not be accepted in place of prototype samples.
 3. Printed physical, electrical and technical data clearly highlighted to show the differences between the proposed substitutions and the specified electrical pole standards.
 4. The Architect and Engineer shall determine whether the prototype sample complies with the specifications and shall reserve the right to disqualify any bidders.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of electrical poles and standards of types and sizes required, whose products have been satisfactorily used in similar service for not less than 5 years.
- B. Installer's Qualifications: Firms with at least 5 years of successful installation experience with projects utilizing electrical pole and standard work similar to that required for this project.
- C. Codes and Standards:
1. Electrical Code Compliance: Comply with applicable local code requirement of the authority having jurisdiction and NEC Articles 220, 225, 250, 410, and 501 as applicable to installation, and construction of electrical poles and standards.
 2. UL Compliance: Comply with UL standards, including UL 486A and 486B, pertaining to electrical poles and standards. Provide lighting components and fittings which are UL-listed and labeled.
 3. ANSI/ASTM Compliance: Comply with applicable requirements of ANSI C 2, "National Electrical Safety Code", pertaining to construction and installation of lighting poles and standards.
 4. NEMA Compliance: Comply with NEMA Standards Pub/No's. LE 2 and TT 1 pertaining to electrical pole and standard units, materials, and installation.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver electrical pole and standard products, and fittings in factory-fabricated containers or wrapping, which properly protect products from damage.

- B. Store electrical pole and standard products and fittings in original cartons in well-ventilated space protected from moisture, construction traffic and debris.
- C. Handle electrical pole and standard products carefully to prevent breakage, denting and scoring finish. Do not install damaged units or components; replace with new.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate with other electrical work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of electrical pole and standard work with other work.
- B. Sequence electrical pole and standard installation work with other work to minimize possibility of damage and soiling during remainder of construction period.

PART 2 - PRODUCTS

2.1 ELECTRICAL POLE STANDARDS

- A. Metal Lighting Standards: Provide metal, raceway-type, lighting poles and standards, of sizes and types shown on schedules, comprised of shafts and tenon joints. Equip with grounding connections readily accessible from handhole or transformer base access doors; and constructed of the following materials and additional construction features:
 - 1. Material: Cast aluminum for pedestrian scale poles, unless otherwise noted.
 - 2. Configuration: Anchor base, or direct burial type mount as indicated on drawings and details, with hand holes and covers as required for code compliant electrical connections. Poles shall be round and straight unless indicated otherwise in the project fixture schedule.
 - 3. Configuration: Transformer base type with access door and cover.
 - 4. Metal Lighting Standard Accessories: Provide accessories for metal lighting standards, including anchor bolts, anchor bolt cover, as recommended by lighting standard manufacturer, of sizes and materials needed to meet erection and loading application requirements.
 - 5. Receptacles: include regressed GFCI outlets in each pole as directed in Project Fixture Schedule.
 - 6. Special requirements at F7 poles: provide for five different control zones, one each for fixture types F7A, F7B and F7C, as well as for receptacle at pole base and receptacle at pole cap.
 - 7. Catenary poles: provide 14', HSS8.625" dia. round straight steel poles for the catenary system. Include all 5/16" dia. stainless steel cables, turnbuckles, cable anchors, and fixture mounting clips as necessary for a complete and functioning system. See structural engineering details for mounting and other related information.

- B. Pole base shall be designed by a professional structural engineer licensed in the state of Colorado who is hired by the contractor / manufacturer to ensure pole base meets AASHTO requirements for the geographical project location.
- C. Provide vibration dampener field or factory installed. Dampener shall be serpentine type, chain type are not permitted. Dampener shall be provided for the following types of poles:
 - 1. Round Poles.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which pole standard, equipment and components are to be installed, and substrate which will support equipment. Notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- B. Confirm that all poles to be mounted to the existing structure have been located and installed in a manner that supports their weight and wind loading and per the project's structural engineering details. Submit shop drawings for review by project structural engineer for formal approval prior to install.

3.2 INSTALLATION OF ROADWAY AND PARKING AREA LIGHTING

- A. Install pole and catenary mounted products in accordance with manufacturer's written instructions, applicable requirements of NEC, NESC and NEMA standards, and with recognized industry practices to ensure that roadway and parking area lighting equipment fulfill requirements.
- B. Utilize belt slings or rope (not chain or cable) to protect finishes when raising and setting finished poles and standards.
- C. Set poles and standards plumb. Support adequately during backfilling, or when anchoring them to the foundations.
- D. Provide sufficient space encompassing hand access and cable entrance holes for installation of underground cabling and conduit.
- E. Fasten electrical lighting fixtures and brackets securely to structural supports, including poles/standards; and ensure that installed fixtures are plum and level.
- F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where

manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and 486B, and the National Electrical Code.

3.3 GROUNDING

- A. Provide equipment grounding connections for poles and standards. Provide a ¾" x 10' copper rod at each pedestrian, parking lot and plaza lighting pole. Connect to a #6 bare copper ground wire. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounding.

END OF SECTION 26 56 13

SECTION 26 90 00 - PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. The contractor shall summarize and document adherence with the requirements of the specifications for project closeout including:
 - 1. Copies of all warranties
 - 2. Operation & Maintenance Manuals
 - 3. Required tests
 - 4. Certifications
 - 5. Record drawings
 - 6. Permit requirements
- B. The contractor shall compile a closeout manual which shall include:
 - 1. A list of all required tests and a place for signoff of date completed.
 - 2. A list of all submittals with dates of acceptance by the engineer.
 - 3. A schedule indicating dates for beginning testing and startup of equipment and dates of tests to be witnessed by the engineer, or designated representative, as required by the specifications.
 - 4. Test procedures to be used for optional systems.
 - 5. Project close out check list.
- C. The final closeout manual shall include the following:
 - 1. Test reports as required by the specifications with signoff by the appropriate individual (engineer, architect, building official, etc.).
 - 2. Documentation indicating all equipment is operating properly and is fully accessible for maintenance.
 - 3. Copies of all warranties.
- D. This section only includes the requirements for documentation of the contract documents, by the contractor, for project completion. This section does not in any way decrease the scope of any of the drawings or specifications.

1.2 SUBMITTALS

- A. Within 90 days after notice to proceed submit a preliminary closeout manual with the following:
 - 1. A list of all required tests.
 - 2. Preliminary schedule showing major milestones for completion of the electrical and technology systems.
- B. Within 30 days of the first major milestone submit the completed closeout manual as described in Part 1.
- C. Within 2 weeks of substantial completion submit a completed "Project Closeout Check List", and the Final Closeout Manual.
- D. Listed below is a checklist for use by the contractor. This list is not all inclusive for this project.

Project Close-Out Summary - Electrical

- ☐ The following tests have been completed. Submit test report for record.
 - ☐ Feeder Testing and Reporting (Megger Result)
 - ☐ Transformers Testing and Reporting
 - ☐ Grounding System Testing and Reporting
 - ☐ Infrared Scans, Testing and Reporting
- ☐ All main components of the electrical system cleaned and vacuumed. This includes unit substations, switchboards, distribution boards, panel boards, etc. Provide ME Engineers with schedule when this is going to occur and a letter stating it has been completed.
- ☐ The contractor shall schedule a walk through with the engineer to inspect all feeder sizes. Covers for panel boards and distribution boards should be removed by the contractor for visual inspection of feeder sizes.
- ☐ The fire alarm system manufacturer shall provide the Owner/Architect with a "Letter of Certification" indicating the system is fully functional and meets all manufacturers requirements as well as code and design requirements. Fire department must sign off the system.
- ☐ Provide spare fuses and fuse cabinets ((1) in each switch gear room) per specifications.
- ☐ Panelboard directories completed with typed print outs.
- ☐ Record drawings submitted.
- ☐ All lighting control systems complete with controls fully operational for visual inspections. The lightning protection system manufacturer shall provide the Owner/Architect with a "Letter of

Certification” indicating the system meets all manufacturers requirements as well as code and design requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EQUIPMENT STARTUP AND TESTING

- A. Prior to completion and punch list by the engineer, the contractor shall startup and test each piece of equipment as required by the specifications. The contractor shall provide documentation of all required tests with signoff of by the appropriate individual (engineer, architect, and building official).

3.2 LIFE SAFETY SYSTEMS

- A. All life safety systems shall be fully and successfully tested by the contractor before being witnessed by the engineer or building official.
- B. The contractor shall provide a detailed test procedure, with instrumentation to be used, for approval by the engineer and building official prior to any testing.
- C. Once tested by the contractor and fully operation the systems shall be demonstrated to the engineer. Once accepted by the engineer the system shall be demonstrated to the building and fire officials.

3.3 COORDINATION WITH OTHERS

- A. The Division 26 contractor shall coordinate their requirements with the general contractor to ensure the other building systems are completed to the point that they will not adversely affect the operation of the Division 26, 27 and 28 systems.

3.4 PUNCH LISTS

- A. The contractor shall submit in writing that the project is ready for final review by the engineer.
- B. Once the project is ready for final review the engineer will create a punch list of any corrections or deficiencies.
- C. The contractor shall complete all punch list items and provide a letter to the architect after completion stating all items have been completed or reasons why they were not completed.

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- D. Upon receipt of this letter the engineer will verify that the punch list has been satisfactorily completed.

END OF SECTION 26 90 00

SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Product Appendixes: Refer to Appendix 1, Equipment Schedules within each specification section for specific product information on the benchmark products. These equipment schedules should be the baseline for product data submittals but are not intended to be an all-encompassing bill of materials.
- B. Part 1 and Part 3 of this specification applies to all Division 27 specification sections.
- C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.
- D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.
- E. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.
- F. Rough carpentry is specified in a Division 6 section.

1.2 SUMMARY

- A. Project Expectations: **Within one week after award of contract, the Contractor shall arrange a “CA kickoff” meeting and/or conference call with the General Contractor, Construction Manager, Architect, Engineer, and Owner (when applicable) to discuss general project expectations.**
- B. The term “provide” used throughout this specification and drawings shall mean “furnish, install, test, and certify”.
- C. Coordinate project schedule, installation schedule, phasing and any other requirements deemed necessary with Construction Manager and/or General Contractor and all necessary trades to ensure successful completion of work.
- D. Phasing, temporary distribution/equipment, cut-over and implementation as called out within the plans, shall be coordinated with Owner, Construction Manager and/or General Contractor, Architect, and Engineer prior to execution.

- E. Extent of communications infrastructure work is indicated by Division 27 specifications and Technology drawings and schedules and is hereby defined to include, but not by way of limitation, the provisions of:
1. Raceway systems including but not limited to conduits, sleeves, telecommunication services entrance, manholes, pull-boxes, junction boxes, back-boxes, etc. as required and specified in Division 27 sections and/or select Division 26 sections. The Construction Manager and/or General Contractor shall coordinate this with the Sub-Contractor performing work and determine how scope of work is assigned. The purpose of this specification is to establish design intent and general system scope.
 2. All communications infrastructure shall be provided as part of the Project including but not limited to raceway, cable, cable terminals, and comm room fit-out.
 3. Backbone cables between the Main Cross-connect (MC) and each Intermediate Cross-connect (IC) or Remote Hub location. Refer to Technology Drawings (one-lines and floor plans) for specific locations and sizes.
 4. Horizontal or station cables between each communication device outlet and the nearest Intermediate Cross-connect (IC) location.
 5. Backbone and horizontal cable termination and terminals including but not limited to wiring panels/blocks, patch panels, fiber optic terminals and panels, and outlets/jacks.
 6. Patch cords, jumper cables, and cross-connect cables to interconnect wiring terminals as well as electronic equipment.
 7. Communication room hardware and component fit-out including cabinets, racks, cable tray, backboard, and raceways for terminating cable and installation of electronic equipment.
 8. Power distribution within equipment racks and cabinets including power strips.
 9. Grounding and bonding of all metallic hardware components to the nearest telecommunications grounding bus (TGB) bar including but not limited to equipment racks, cabinets, cable trays, ladder rack, metallic cable sheaths, wall mounted wiring terminals, conduits, sleeves, metallic ductwork, and frames.
 10. All physical cable management hardware including, but not limited to: "J-hooks" in accessible ceiling areas, "D-rings" on backboards, vertical and horizontal managers on racks and cabinets, vertical and horizontal ladder-type or wire basket cable tray within communication rooms, etc.
 11. Fire stopping as required. Contractor shall provide fire stopping for all low-voltage openings (including empty low voltage raceway) once cable installation is complete. Confirm specific fire stopping scope requirements with General Contractor and/or Construction Manager.
 12. Testing of all communications cable infrastructure and grounding systems as noted by specification, drawings, and applicable industry standards.
 13. Labeling of all communication infrastructure components, hardware, cable, and terminations with mechanically printed labels.
 14. Preparation and submission of product data, shop drawings, testing reports, as-built drawings, and cabling documentation as required in this specification.
 15. Construction and Installation warranties.
 16. Manufacturer components, channel and solutions warranties.
 17. Installation and testing of all system and components.

18. Onsite administrative and user training.
19. Manufacturer training of components.

1.3 SUBMITTALS

A. General Description and Requirements

1. Refer to Product Data and Shop Drawing Submission Checklist (appendix) at the end of this specification section for additional requirements specific to each Division 27 section.
2. Contractor shall not submit product data for review without submitting corresponding shop drawings as part of the same submittal package. Partial submittals will be returned as “revise and resubmit”.
3. Submittal Schedule:
 - a. Within (1) week after award of contract, the Contractor shall submit a proposed schedule for submitting product data and shop drawings. At a minimum, the following items shall be included:
 - 1) Submittal date for Compliance Matrix.
 - 2) Submittal date for Construction Schedule.
 - 3) Submittal date for Product Data and Shop Drawings.
 - 4) Submittal date for Commissioning and/or Test Results.
 - 5) Submittal date for As-Builts.
 - b. Within **15** days after award of contract or as dictated by the construction schedule (whichever period of time is shorter), the Contractor shall submit prefabrication submittals consisting of product data and shop drawings for approval. Partial submittals will not be accepted without prior written approval from the Architect.
4. In addition to the requirements noted herein, refer to Division 1 Specification for additional requirements. As a minimum, Contractor shall ensure all requirements listed here are met.
5. Review of the Prefabrication Submittals by the Architect and Engineer is for purposes of tracking the work and contract administration and does not relieve the Contractor of responsibility for any deviation from the Contract Documents, or from providing equipment and/or services required by the Contract Documents which were omitted from the prefabrication submittals.
6. No portion of the project shall commence nor shall any equipment be procured until the prefabrication submittals (including product data and shop drawings) have been approved in writing by the Architect. All installations shall be in accordance with the Contract Documents.
7. A detailed completion schedule shall be submitted with the prefabrication submittals.
8. Prefabrication submittals shall be accompanied by a letter of transmittal identifying the name of the project, Contractor's name, date submitted for review, and a list of items transmitted.

B. Compliance Matrix:

1. Compliance Matrix: Provide a specification compliance matrix indicating compliance or deviation for each item in the specification. Refer to the SPECIFICATION RESPONSE section within this specification and Appendix 2 for additional requirements.

C. Product Data:

1. Warranty Information: Provide all warranty information as described in this specification section for review and approval.
2. Component List: Provide complete submittal component list (i.e. table of contents) at the beginning of the submittal package. Component list and manufacturer cut-sheets shall be compiled to match the order of each Appendix. Component list shall include:
 - a. Component name
 - b. Manufacturer
 - c. Specific product number (to clearly indicate special options, colors, etc.)
3. Cut-Sheets: Submit manufacturer's cut-sheets on all components listed within this specification and corresponding appendix. All components and parts being used shall be highlighted in color on cut-sheets to distinguish specific product/part numbers, options, colors, accessories, etc.
4. Product Substitutions: These specifications are intended to be performance based, thus all products listed in each respective Appendix 1: Equipment Schedules are "benchmark" products. The Contractor may submit (as a proposed alternate solution) substitute manufacturers and models that may be more cost effective or readily available. All substitutions shall meet or exceed the minimum functional, physical, and technical specifications. Acceptance of such substitutions is at the discretion of the Owner, Architect, and Engineer. Additionally, the requirements of Division 1 Specifications shall apply and may supersede requirements noted herein.

D. Prefabrication Shop Drawings: (Refer to Appendix-3 for additional requirements)

1. General: All shop drawings shall be provided on contractor specific title block. Contractor may use Technology Drawing files as a "starting point" for shop drawings but additional information shall be added and/or updated as noted below.
2. Symbol Legend, Abbreviations, and Description: Drawings shall include the following:
 - a. General project information, contractor company name, etc.
 - b. Descriptions of all abbreviations and symbols
 - c. Typical device mounting heights
 - d. General notes and/or scope description, exclusions, etc.
3. One-Line Wiring Diagrams: Provide backbone raceway one-line, backbone and horizontal cabling, copper pair and fiber strand counts, cable quantities, splice enclosures, etc. Include conduit allocation and fill ratios for all conduits on the raceway one-line diagram.

4. Site Plan: Provide complete site and exterior plans indicating all site and building façade mounted communication device outlets, equipment, and components proposed to be installed. Additionally, manholes, pull-boxes, and all major raceway routing shall be indicated for conduits 2-inches and larger. Shop drawings shall represent final conduit routing and manhole and/or pull-box placement as coordinated and/or confirmed with Service Provider, Civil Engineer and other trades.
5. Enlarged Plans:
 - a. Provide 1/4" = 1'-0" enlarged plans of all communication rooms (as applicable) indicating the position of equipment cabinets and/or racks, wiring terminals, patch panels, grounding equipment, cable tray, fiber and copper terminations, and other low voltage systems equipment layout within the rooms.
 - b. Shop drawings shall clearly indicate final conduit/riser (core drill and/or block-out) locations and sizes as coordinated and/or confirmed with Structural Engineer and any field conditions that impact proposed location.
 - c. Shop drawings shall clearly indicate areas where equipment clearances may be limited, for review and approval by Owner, Architect, and Engineer.
6. Details: Document method of attachment of racks to the floor and ladder tray systems, method of attachment of wall mounted distribution frames, grounding details indicating grounding method for cabinets, racks, cable tray, cable management, and power details for rack mounted power distribution.
7. Elevations:
 - a. Rack elevations (produced in Visio, ACAD, or similar) indicating exact placement of patch panels, fiber terminals and enclosures, vertical and horizontal cable managers, rack mounted power strips or distribution units, empty rack-units, etc.
 - b. Wall elevations shall detail any and all known components to be mounted on the walls, whether those items are provided by Contractor producing shop drawings or not. Components shall include, but not be limited to, electrical and/or fire alarm panels, security panels, distributed antenna system (DAS), CATV, communication infrastructure distribution frames with block size, cable routing, cable management, pair counts, method of attachment, etc.
8. Drawing Scale: Shop drawings shall be drawn to scale and completely dimensioned as to clearly show construction detail.
9. Labeling: Provide documentation of all labeling schemes for conduit, back-boxes, cables, outlets, wiring blocks and/or patch panels, device faceplates, etc.
10. Documentation: Provide submittals and documentation as required by the project manual (in addition to electronic copies) for review or as indicated in Division 1 general conditions.

E. Record As-Built Drawings:

1. All record as-built drawings shall be provided on contractor specific title block. Contractor may use Technology Drawing files and/or shop drawings as a "starting point" for as-built drawings. As-built drawings shall comply with shop drawing requirements

above, but shall be updated to align with actual installation. Additionally, area plan drawings shall indicate all device labeling including, but not limited to, tele/data port labels.

1.4 QUALITY ASSURANCE

A. Codes and Standards: All materials and installations shall comply with current applicable codes and standards, including but not limited to:

1. TIA-526: Standard Test Procedures for Fiber Optic Systems.
2. TIA-568-C.0: Generic Communications Cabling for Customer Premises.
3. TIA-568-C.1: Commercial Building Communications Cabling Standards, Part 1: General Requirements.
4. TIA-568-C.2: Balanced Twisted-Pair Communications Cabling and Components Standard.
5. TIA-568-C.3: Optical Fiber Cabling Components Standard.
6. TIA-569-A: Commercial Building Standard for Telecommunications Pathways and Spaces.
7. TIA-606-A: Administrative Standard for Commercial Telecommunications.
8. ANSI/J-STD-607-A: Commercial Building Grounding and Bonding Requirements for Communications.
9. TIA-758-A: Customer-Owned Outside Plant Communications Cabling Standard.
10. TIA-942: Telecommunications Infrastructure Standard for Data Centers.
11. ASTM: American Society for Testing and Materials
12. BICSI CO-OSP Design Manual (current edition): Customer-Owned Outside-Plant Design Manual.
13. BICSI Electronic Safety and Security (ESS) Design Reference Manual (current edition).
14. BICSI TDM Telecommunications Distribution Methods Manual (current edition).
15. TIA TSB67: Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling.
16. ICEA: Insulated Cable Engineers Association
17. IEEE-802.3: 10Mb/s, 100Mb/s, 1Gb/s, and 10Gb/s Ethernet Standards as applicable based on media types (twisted pair copper, fiber optics, etc.)
18. IEEE-802.3ak: 10Gb/s Ethernet (evolving copper standard).
19. IEEE-802.3af: Power-over-Ethernet (PoE).
20. IEEE-1100-1999: Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.
21. IEEE-241: Recommended Practice for Electric Power Systems in Commercial Buildings.
22. ISO/IEC 11801: International Standard on Information Technology – Generic Cabling of Customer Premises.
23. NESC: National Electrical Safety Code
24. NEMA Std 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
25. NFPA-70/NEC: National Electrical Code.
26. NFPA-72: National Fire Alarm and Signaling Code
27. UL Compliance: Provide products which are UL-listed and labeled.
28. USDA Bulletin 1751F-643: Underground Plant Design.

B. Manufacturer and Product Qualifications

1. Provide products from manufacturers regularly engaged in the production of communications infrastructure components, including but not limited to, raceway, horizontal copper cabling, copper and fiber optic backbone cabling, and connecting hardware.
2. Provide products from manufacturers whose products of similar types, capacities, and characteristics have been in satisfactory use in similar type projects for not less than five years.

C. Contractor Qualifications:

1. Firms with at least seven (7) years of successful installation experience with projects utilizing communications structured cabling, media systems, infrastructure, raceway and equipment similar to that required for this project.
2. The company shall have a fully staffed office with technical installations support personnel within 30 miles of the project. (Exceptions to this shall be confirmed through approval by the Owner, Architect, Contractor, and Engineer.)
3. The Low Voltage Raceway Contractor shall be a certified installer (current and in good standing with proven history) of the selected manufacturer's raceway systems and shall provide a 25-year warranty on installation and applications.
4. The Low Voltage Cabling Contractor shall be a certified installer (current and in good standing with proven history) of the selected manufacturer's structured cabling systems, and shall provide a 25-year warranty on structured cabling installation and applications.
5. The company shall have a BICSI RCDD on staff.

D. All materials shall be Underwriters Laboratories (UL) or Intertek Testing Services (ETL) Listed unless otherwise indicated.

E. Coordinate with local communications service provider(s) for primary and diverse service to Telecommunications Demarcation location(s) within the facility.

F. Coordinate with electrical work and other trades to properly interface installation of telephone system with other work.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment and components in factory-fabricated containers or wrappings, which properly protect equipment from damage.
- B. Store equipment and components in original packaging. Store inside in a well-ventilated space protected from weather, moisture, soiling, humidity, and extreme temperatures.
- C. Handle equipment and components carefully to prevent damage. Do not install damaged units or components; replace with new.

1.6 SEQUENCING AND SCHEDULING

- A. All work shall be reviewed and coordinated with the Construction Manager and/or General Contractor prior to commencing.
- B. Communication systems, infrastructure, raceway and equipment are sensitive to environmental conditions including but not limited to temperature, dirt, dust, and water. The contractor shall ensure the storage and installation of all communication components are sequenced and scheduled accordingly to prevent any damage, loss of performance, and warranty void of such systems. All mis-installed components shall be replaced with new parts and re-installed at the Contractor's expense.
- C. Coordinate installation with Structural, Electrical, HVAC, Plumbing, Fire Protection, and other trades to eliminate disruption and/or conflict with other systems.
- D. Coordinate underground installation with Civil, Structural, Electrical, and other trades to eliminate disruption and/or conflict with other systems (paving, curb and gutter, etc.).
- E. Sequence installation of communications systems and infrastructure with other work to minimize possibility of damage and soiling during remainder of construction.

1.7 PROJECT SITE CONDITIONS

- A. Prior to submitting a proposal, the Contractor shall inspect the Contract Documents, and shall become fully informed as to laws, ordinances, and regulations affecting the project. The Contractor shall immediately bring to the Owner, Architect, and Engineer's attention, in writing, any existing condition or statute that contradicts, is in conflict with, or negates the Contract Documents. Failure of the Contractor to become fully informed as to all above mentioned items shall in no way relieve the Contractor from any obligations with respect to their proposal.
- B. The Technology Drawings depict equipment locations, backboxes, conduit runs, cabling, etc. in a schematic manner. Field conditions and coordination with related trades may warrant relocations of field devices. No additional compensation will be allowed due to these revisions.

1.8 WARRANTY

- A. The manufacturer shall provide a warranty with a minimum term of 25-years for structured cabling and all communications cable infrastructure components. This warranty shall cover all components including cables, jacks, patch panels, and wiring panels, etc. to maintain the specified performance, physical criteria, and applications assurance. Any such components, link, or channel shall be replaced by the Manufacturer at no cost to Owner during this period. The Contractor and Manufacturer shall submit all information and documentation on Warranty.

- B. A one (1) year warranty on the Work shall be provided by the Contractor. If, within one (1) year after the date of final acceptance of the installation or within such longer period of time as may be prescribed by law or by the terms of any applicable special warranty required by the Contract Documents or provided by a manufacturer, any of the work or equipment is found to be defective or not in accordance with the Contract Documents, the Contractor shall correct it promptly including all parts and labor after receipt of notice from the Owner to do so unless the Owner has previously given the Contractor a written acceptance of such condition. This obligation shall survive termination of the contract. The Owner shall give such notice promptly after discovery of the condition. Such notice shall be provided by Owner representatives, to be identified, either verbally or in writing.
- C. Nothing contained in the Contract Documents shall be construed to establish a shorter period of limitation with respect to any other obligation which the Contractor might have under the Contract Documents or any manufacturer's warranty. The establishment of the time period noted above, after the date of final acceptance or such longer period of time as may be prescribed by law or by the terms of any warranty required by the Contract Documents, relates only to the specific obligation of the Contractor to correct the work or equipment, and has no relationship to the time within which his obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to his obligations other than specifically to correct the work or equipment.
- D. If system operation is not fully restored during the warranty period within two (2) business days, the Owner reserves the right to require the Contractor to provide on-site manufacturer's service technicians at no additional cost.
- E. The Owner reserves the right to expand or add to the system during the warranty period using firm(s) other than the Contractor for such expansion without affecting the Contractor's responsibilities, provided that the expansion is done by a firm which is an authorized dealer or agent for the equipment of system being expanded.

1.9 SPECIFICATION RESPONSE

- A. Compliance
 - 1. Provide a specification COMPLIANCE MATRIX indicating compliance or deviation for each item in the specification. The matrix shall be comprised of a list of all numbered paragraphs that appear in this Specification. This matrix is critical for proposal evaluation. Failure to submit may result in the disqualification of the bid. See example Compliance Matrix template in Appendix 2.
 - 2. Additionally, as described in this Specification, bidders shall submit the following information with their submittal:
 - a. Manufacturer's literature sheets for all standard manufactured items included in the equipment list and as proposed in the Voluntary Alternate Bid form, if applicable.

- b. Workload and capability statements. The statements shall detail projects that will be active during the completion of this project, and the manpower that would be available for this project.
- c. Confidentiality and return statements. The statements shall guarantee that the Contract Documents shall not be copied or distributed physically or verbally. The Contractor shall also assure the Owner that the Contract Documents shall be returned in their entirety upon request. The successful Contractor will be provided with as many copies as requested.
- d. Copy of manufacturer's certification certificate.

1.10 DEFINITIONS

A. Acronyms and Definitions

- 1. Refer to Technology Symbol Legend and Abbreviations shown on drawings.

PART 2 - SPECIFICATIONS

2.1 GENERAL REQUIREMENTS

A. Refer to each of the specification sections listed below for requirements:

- 1. 27 05 26: Telecommunications Grounding and Bonding
- 2. 27 05 33: Telecommunications Raceway and Boxes
- 3. 27 05 36: Cable Trays
- 4. 27 05 43: Underground Ducts, Raceways and Manholes
- 5. 27 11 00: Communications Equipment Room Fit-out
- 6. 27 13 13: Communications Copper Backbone Cabling
- 7. 27 13 23: Communications Fiber Optic Backbone Cabling
- 8. 27 15 00: Communications Horizontal Cabling

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. General:

- 1. The Contractor shall comply with all project expectations and submittal requirements as indicated in Part 1 of this specification. This includes initiating a "CA kickoff" meeting to discuss general project expectations with the project team.
- 2. Examine areas and conditions under which communications systems and infrastructure are to be installed. Notify Owner, Architect, and Engineer in writing of conditions

- detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer.
3. The Contractor shall be knowledgeable of work to be performed by other trades and take necessary steps to integrate and coordinate their work with other trades.
 4. The Contractor is required to coordinate their efforts with the other trades and sub-contractor who may be working within the same vicinity to avoid conflict and lost time.
 5. The Contractor shall be responsible for furnishing all materials indicated on the drawings or as specified herein for a complete communications system.
 6. The Contractor shall supply all necessary tools, equipment, accessories, safety equipment, protective clothing, etc., as customary for the craft and necessary for the installation.
 7. All communications infrastructure shall be installed in an aesthetically pleasing fashion. All surface raceway in new buildings must be approved by the Owner, Architect, and/or Engineer.
 8. All communications infrastructure shall be installed for optimal performance.
 9. All communications infrastructure shall be installed to allow for convenient operation, testing, and easy adds, moves, and other changes in the future.
 10. All components noted in Technology drawings and specifications shall be provided and completely setup and installed.
 11. The Contractor shall verify space requirements and locations before starting cable installations and terminations. Inappropriate conditions shall be immediately reported to Construction Manager or General Contractor, Owner, Architect, and Engineer prior to initiating installation.
 12. The contractor shall not install any component in a manner or condition that will void manufacturer and/or contractor warranty. Any such conditions that prevent an acceptable install shall be immediately reported to Construction Manager or General Contractor, Owner, Architect, and Engineer prior to initiating installation. All mis-installed components will be removed and replaced with new at the Contractors expense. No additional cost will be submitted to Owner.

B. Communications Room Fit-out:

1. Construction within communication rooms must be substantially complete before the installation of telecommunications cabling. This includes, but is not limited to, the installation of plywood backboard, cable tray or ladder rack, electrical outlets, light fixtures, sprinklers and ductwork. All walls shall also be painted before the installation of telecommunications cabling.
2. Communications rooms must be free from dust, dirt, and other foreign materials before the installation of any termination hardware or the termination of copper or fiber optic cables. The door to the telecommunication rooms must be installed and closed during termination.
3. Floor to floor distribution shall be provided with concrete floor sleeves or conduits as noted on the drawings, and as required by the architectural design.

C. Communications Raceway Infrastructure:

1. Contractor shall provide conduits through walls and across inaccessible ceiling spaces to ensure unobstructed pathway back to the nearest communications room or cable tray.
2. Provide protective cable bushings on all conduits immediately after installation.
3. Use only electrical 45° or 90° conduit elbows with long bend radii as follows:
 - a. 6:1 bend radius of the inside conduit diameter for sizes less than 2-inches.
 - b. 10:1 bend radius of the inside conduit diameter for sizes 2-inches and greater.
4. Do not place more than two 90° sweeps or exceed 100 ft. between pull boxes without providing a pull box.
5. Fire-seal all raceway penetrations and openings to maintain fire rating after communications cables are installed.
6. Cable fill in riser conduits shall not exceed 40% cable fill.
7. Where applicable, the Contractor shall verify existing cable fill in riser conduit before installation of additional cables so as not to exceed 40% cable fill. Contractor will be responsible for installation of additional riser conduit, where additional cables to be added will exceed the 40% cable fill.

D. Communications Cabling Infrastructure:

1. Contractor shall not paint cables and/or spray cables with fire proofing material as it can affect cable performance and will void the cable warranty.
2. All communications cable routed within communications rooms shall be bundled and combed to provide a neat and organized appearance. Cables shall be bundled using only manufacturer and industry approved Velcro wire ties (zip ties shall not be used) with tensions that do not deform and damage cable resulting in loss of transmission or performance. Any bundles and combing methods used shall not exceed manufacturer or industry standards recommendations for that cable type.
3. Contractor shall provide dedicated J-hooks at 48-inches on-center for all communications cabling not run in conduit or cable tray.
4. The contractor shall not install any cable in conduits that do not have the appropriate protect bushings on conduit ends. All mis-installed cable will be removed, bushings installed, and new cable re-installed at the Contractors expense. No additional cost will be submitted to Owner.
5. Cable bends shall not be greater than that recommended by the manufacturer of the cable.
6. Care shall be taken so as not to damage cable during the installation process and that manufacturer's pull tension specification is not exceeded.
7. Provide a minimum 8'-0" and maximum 10'-0" of slack. Loop at the IC-rooms to be contained on the horizontal cable tray or ladder rack.
8. Provide a minimum of 3'-0" of slack for all device cable termination points. Slack shall be contained in accessible ceiling near the final termination point or in the cable tray nearby when continuous conduit is routed back to cable tray.
9. Communications cabling that is bundled within cable trays and supported from j-hooks shall be snugly wrapped using Velcro reusable cable ties as minimum of every 3'-0" for cable organization. Velcro ties shall be tightened so as not to deform cable jackets and

thus affect cable performance. Plastic cable tie wraps shall not be used anywhere on the project.

10. Any other Low Voltage scopes including but not limited to BMS, Fire Alarm, AV and Broadcast cabling that are run in common communications infrastructure shall comply with the installation requirements in the division 27 specifications. The Contractor shall ensure that all scopes that use the installed infrastructure comply with these guidelines or provide dedicated pathways for those systems.

3.2 LABELING

- A. All communications components shall be clearly labeled using labeling devices (i.e. handwritten labels are not acceptable) with white label and black text. All labels shall be consistent font type and size (for respective components).
- B. The following indicates the recommended labeling scheme for various components. The final labeling scheme shall be coordinated with the Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.
 1. Backbone Cables (to TRs):
 - a. Label provided at both ends shall indicate origin room such as MTR (Main Telecom Room), the TR room designator (where cable is routed to) and a cable number if multiple cables are provided to a single TR location.
 - 1) Example: "MTR-3A" = single cable from MTR to TR on level 3, riser A.
 - 2) Example: "MTR-3A-2" = cable 2 of multiple cables from MTR to TR on level 3, riser A.
 2. Backbone Cables (to Remote Hubs):
 - a. Label provided at both ends shall indicate point of origin (i.e. MTR or TR designator), enclosure designator (where cable is routed to) and a cable number if multiple cables are provided to a single TR location.
 - b. Enclosure boxes shall be indicated by an "E" followed by a number for the enclosure.
 - 1) Example: "MTR-E1" = single cable from TR to enclosure box "1".
 - 2) Example: "3A-E4" = single cable from TR-3A to enclosure box "4".

3. Horizontal Cables:
 - a. Label provided at both ends shall indicate point of origin (i.e. MTR or TR designator), patch panel designator (A, B, C, etc.), and port number (01, 02, 03, etc.).
 - 1) Example: "MTR-A.23" = horizontal cable originating from port "23" on patch panel "A" at the MTR.
 - 2) Example: "3A-C.23" = horizontal cable originating from port "23" on patch panel "C" at TR-3A.
4. Device Faceplates:
 - a. Label provided at each faceplate shall indicate point of origin (i.e. MTR or TR designator) for cables terminated at that device.
 - 1) Example: "MTR" = Device faceplate for cables originating from the MTR.
 - 2) Example: "3A" = Device faceplate for cables originating from TR-3A.
5. Device Outlets:
 - a. Label provided at each device jack/outlet shall indicate patch panel designator (A, B, C, etc.) and port number (01, 02, 03, etc.) for cable point of origin.
 - 1) Example: "A.23" = horizontal cable originating from port "23" on patch panel "A" at the room indicated on the faceplate label.
6. Patch Panels (Horizontal and Backbone Cable Terminations):
 - a. Labels provided at patch panels for HORIZONTAL cable terminations shall start with "A" for the first patch panel (in each room) and letter sequentially (B, C, etc.) thereafter.
 - b. Labels provided at patch panels for BACKBONE cable terminations shall start with "AA" for the first patch panel (in each room) and letter sequentially (BB, CC, etc.) thereafter.
 - c. Patch panel ports shall be labeled for each panel starting with "1" or "01" and numbering each port sequentially.
7. Fiber Termination Panels
 - a. Label provided at termination panels for backbone or horizontal fiber optic cabling shall start with "1" for the first panel (in each room) and number sequentially (2, 3, etc.) thereafter.
 - b. Fiber termination panel ports shall be labeled for each panel starting with "1" or "01" and numbering each port sequentially.

8. Wiring Blocks (Copper Backbone Terminations, if applicable)
 - a. Label provided at termination panels for copper backbone cabling shall start with "1" for the first block (in each room) and number sequentially (2, 3, etc.) thereafter.
9. Cabinets / Racks
 - a. Label provided at cabinets shall start with "CABINET-1" for the first cabinet (in each room) and number sequentially (CABINET-2, etc.) thereafter.
 - b. Label provided at racks shall start with "RACK-1" for the first rack (in each room) and number sequentially (RACK-2, etc.) thereafter.
10. Grounding Busbars
 - a. Labels are not required for the grounding busbars.
11. Grounding Conductors
 - a. Label provided at the TMGB end of the Telecommunications Bonding Backbone (TBB) shall indicate the Communications Room where the cable originates from.
 - 1) Example: "5A" = TBB originating from TR-5A, routed down through Riser-A Communications Rooms and terminated on the TMGB.
 - b. Label provided at each end of a Grounding Equalizer (GE) cable interconnecting two I-TGBs shall indicate both Communications room designators.
 - 1) Example: "3A-3D" = GE routed between I-TGBs in TR-3A and TR-3D.
 - c. Label provided at each end of grounding cable routed from a ground busbar to the nearest Electrical Ground Busbar shall indicate the Communications room designator and "EGB" for nearest "Electrical Grounding Busbar."
 - 1) Example: "3A-EGB" = Grounding conductor routed between TGB in TR-3A and the EGB in the nearest Electrical Room.
 - d. Label provided at each end of the Equipment Bonding Conductors (EBC) interconnecting each rack, cabinet, ladder rack, etc. within a Communications Room back to the TGB or TMGB shall start with "1" for the first cable (in each room) and number sequentially (2, 3, etc.) thereafter.
12. Conduits
 - a. Label provided each end of Low Voltage conduits shall indicate the point of origin for the opposite end, such as the Communications Room designator or device location Room Number.

- b. Final room number labeling shall be coordinated with the Owner, Architect, and Engineer prior to initiating work.
- c. Horizontal device conduit originating from a nearby cable tray (if applicable) shall indicate "TRAY" at the device end and the device location (i.e. room number) at the cable tray end.
- d. Horizontal device conduit originating from accessible ceiling directly above a device does not require labels at either end.
- e. Conduit sleeves (10-ft or shorter) do not require labels at either end.

13. Pull-boxes

- a. Label provided pull-boxes or conduit ends terminating into a pull-box shall clearly indicate where each conduit originates from, based on "conduit" section above.

END OF SECTION 27 05 00

APPENDIX 1 - EQUIPMENT SCHEDULE

NOTE: There is no product number appendix for this section. Refer to other Division 27 specification sections for specific product information.

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	EXPLANATION
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

APPENDIX 3 - PRODUCT DATA & SHOP DRAWING SUBMISSION CHECKLIST

NOTE: Contractor shall utilize checklist below to ensure comprehensive product data and shop drawings are submitted for review, including submittals compiled between multiple sub-contractors (as applicable). This checklist is intended help establish submittal expectations specific to each specification section and to serve as a pre-check document for each contractor. Refer to submittal section of these specifications for additional requirements.

	GENERAL ITEMS
	Compliance matrix
	Proposed project schedule (procurement, installation, final testing/punch, etc.)
	PRODUCT DATA
	Manufacturer warranty information
	Equipment component list
	Equipment specification sheets
	Refer to 27 05 00 section 1.3-C for additional requirements.

	SHOP DRAWINGS
	27 05 00 (General requirements, applicable to all specification sections)
	All shop drawings, product data and compliance matrix to be submitted together
	Combined legends, plans, details, etc. may be provided to encompass multiple specification sections
	Refer to 27 05 00 section 1.3-D for additional requirements.

	27 05 26
	27 05 26 and 27 11 00 to be submitted together
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	One-lines: indicate all cable types/rating, routing, connection points, labeling, etc.
	Details: indicate busbar components, connection types/points, etc.

	27 05 33
	27 05 33, 27 05 36, and 27 05 43 to be submitted together
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	One-lines: indicate riser conduits / tray, conduit allocation per system (including spares), etc.
	Site plan: indicate other utilities, manholes, conduit types, entry points, light pole tie-ins, etc.
	Floor plans: indicate rated walls/floors, tray/conduit routes, floor boxes, pull-boxes, plenum boxes, etc.
	Details: indicate conduit support systems, grounding, fire-proofing methods, etc.

	27 05 36 (submit cable tray specific shop drawings with RCPs shown)
	27 05 33, 27 05 36, and 27 05 43 to be submitted together
	Legend: indicate symbol key (including mounting height tags), scope clarification notes, etc.
	RCPs: indicate ceiling types, rated walls/floors, tray/conduit routes, access/clearances, etc.
	Details: indicate tray support systems, grounding, fire-proofing methods, etc.

	27 05 43
	27 05 33, 27 05 36, and 27 05 43 to be submitted together
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	Site plan: indicate other utilities, manholes, conduit types, entry points, light pole tie-ins, etc.
	Floor plans: indicate conduit stub-up locations within building, conduit type transition points, etc.
	Details: indicate conduit trench, spacers, grounding, etc.

	27 11 00
	27 05 26 and 27 11 00 to be submitted together
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	Floor plans: indicate rack positions, ladder rack, conduit allocation and stub-up locations, etc.
	Wall elevations: indicate wall mounted cable tray, conduit stub-ups, wall mounted SCPs, CATV, DAS, etc.
	Rack elevations: indicate patch panels, cable managers, PDUs, UPS, network equipment, etc.
	Details: indicate cable tray mounting details, conduit supports, rack-to-floor attachments, etc.

	27 13 13
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	One-lines: indicate all cable types/rating, routing, termination types, labeling, etc.
	Rack elevations: submit with 27 11 00
	Details: indicate termination plate details and placement in remote enclosures, AV racks, etc.

	27 13 23
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	One-lines: indicate all cable types/rating, routing, termination types, labeling, etc.
	Rack elevations: submit with 27 11 00
	Details: indicate termination plate details and placement in remote enclosures, AV racks, etc.

	27 15 00
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	Site plan: indicate OSP cable routes, encoder locations, light poles, pedestals, etc.
	Floor plans: indicate updated comm room divider lines, device labels, typical conduit paths, etc.
	Rack elevations: submit with 27 11 00
	Details: indicate termination plate details and placement in remote enclosures, AV racks, etc.

SECTION 27 05 26 - TELECOMMUNICATIONS GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Product Appendix: Refer to Appendix 1, Equipment Schedules, for specific product information on the benchmark products. These equipment schedules should be the baseline for product data submittals, but are not intended to be an all-encompassing bill of materials.
- B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.
- C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.
- D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.
- E. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.
- F. Rough carpentry is specified in a Division 6 section.

1.2 SUMMARY

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.
- B. Extent of telecommunications grounding and bonding work is indicated by Technology Drawings (one-line, enlarged plans, and details) and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.
- C. A dedicated telecommunications ground system shall be provided with insulated bonding backbones (TBB) as applicable, equalizing conductors (TEC) as applicable, and pre-drilled tinned copper busses (TMGB and TGB) shall be provided at each communications room to bond metallic equipment and hardware components.
- D. Applications of telecommunications grounding and bonding work in this section includes, but may not be limited to: raceways such as conduits and cable trays, metallic cable sheaths, equipment enclosures, cabinets and racks, building structure, electrical power and/or grounding systems components, service equipment, etc.
- E. Refer to other Division 26 and Division 27 sections for wires/cables, telecommunications raceways, boxes and fittings, and wiring devices which are required in conjunction with telecommunications grounding and bonding work; not work of this section.

1.3 SUBMITTALS

A. General Description and Requirements

1. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

B. Product Data:

1. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

C. Prefabrication Shop Drawings:

1. One-Line Wiring Diagrams: Include one-line wiring diagrams for telecommunications grounding and bonding work which indicate layout of ground rods, location of system grounding electrode connections, routing of grounding electrode conductors, equipment grounding connections and busbars.
2. Details: Indicating grounding method for cable tray and cabinets and/or racks.
3. Labeling: Provide documentation of all labeling schemes for grounding busbars and grounding conductors.
4. Documentation: Provide an electronic copy for review or as indicated in Division 1 general conditions.

1.4 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 5 years.

C. Installer's Qualifications: Firms with at least 5 years of successful installation experience on projects with telecommunications grounding work similar to that required for project.

D. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and the current edition of the NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.
2. UL Compliance: Comply with applicable requirements of UL Standards No.'s 467, "Electrical Grounding and Bonding Equipment", and 869 "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits and equipment. In addition,

comply with UL Std 486A, "Wire Connectors and soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL-listed and labeled for their intended usage.

3. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.
4. TIA Compliance: Comply with applicable requirements and recommended installation practices of the current editions of TIA Standards 568, 569, and 607.
5. BICSI Compliance: Comply with applicable requirements and recommended installation practices of the current editions of BICSI Standards TDM, CO-OSP, Data Network Design Reference Manual, and Wireless.

PART 2 - SYSTEM REQUIREMENTS

2.1 GENERAL

A. Materials and Components:

1. Provide telecommunications grounding and bonding system; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is installer's option. Where materials or components are not indicated provide products which comply with NEC, UL, IEEE, NEMA, ANSI, TIA, and BICSI requirements and with established industry standards for those applications indicated.

2.2 BUS BARS

A. Materials and Components:

1. Provide telecommunications grounding bus bars with a TIA J-STD-607-A style and BICSI recommended bolt pattern.

B. Telecommunications Grounding Busbar (TMGB, TGB):

1. Refer to Technology Drawings (grounding details) for additional requirements such as bonding conductor connections and dual busbar locations (such as TMGB) as applicable. Contractor shall provide multiple busbars if necessary, to accommodate the quantity of grounding cables that shall tie into the busbar, in particular the TMGB on larger projects.
2. Provide tinned copper UL listed bus with pre-drilled two-hole bonding lugs.
3. Pre-drilled holes shall be primarily for 4 AWG two-hole bonding lugs. Holes shall be a nominal diameter of 5/16-inch (8mm) with 5/8-inch (16mm) between the holes centerline.

4. Grounding busbar shall also have a minimum of (6) pre-drilled two-hole lug points for #3/0 AWG bonding lugs. Holes shall be a nominal diameter of 7/16-inch (11mm) with 1-inch (25mm) between the holes centerline.
5. Grounding busbar shall have isolated stand-offs to provide a minimum 1-inch clearance off of wall.
6. Physical Size: 20-inch x 4-inch x 1/4-inch (600mm x 100mm x 6mm).

2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600V unless otherwise required by applicable Code or authorities having jurisdiction.
 1. Telecommunications Bonding Backbone (TBB): Provide #3/0 AWG, unless noted otherwise.
 2. Telecommunications Grounding Equalizers (GE): Provide #3/0 AWG, unless noted otherwise.
 3. Tap Conductors: Provide #3/0 AWG unless noted otherwise.
 4. Equipment and Component Bonding Conductors (EBC): Provide No. 4 or No. 6 AWG, insulated stranded conductors based on conductor distances.
 5. ESD Floor Bonding Strap: Provide/install bonding strap in accordance with the flooring manufacturers requirements.

2.4 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Compression Fittings: All cable splices from bonding backbone to tap conductors shall use irreversible compression fittings to join cable ends.
- C. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 1. Pipe Connectors: Clamp type, sized for pipe.
- D. Welded Connectors: Exothermic-welding kits of types recommended by Cadweld (or approved equal) manufacturer for materials being joined and installation conditions.
- E. Compression Fittings: All cable splices from bonding backbone to tie cables shall use irreversible compression fittings to join cable ends.

2.5 GROUNDING ELECTRODES

- A. Ground Rods and Electrodes for use in telecommunications manholes:
 - 1. Ground Rods: Copper clad steel; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.
 - 2. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
 - a. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
 - b. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Stranded conductors shall be used for all telecommunication ground cables, unless otherwise indicated.
- B. Underground Grounding Conductors: Install, #3/0 AWG insulated copper conductors in conduits.
 - 1. Bury at least 24 inches (600 mm) below grade or below frost line (whichever is deeper).
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- C. Telecommunications Main Grounding Bus (TMGB):
 - 1. Refer to Technology drawings for exact location.
 - 2. Install bus on insulated spacers 1-inch (25 mm) minimum, from wall and 12-inches (300 mm) above finished floor, unless otherwise indicated.
 - 3. The TMGB shall be connected to the main electrical service ground bus with an insulated #3/0 (120mm²) stranded grounding conductor installed in continuous conduits.
 - 4. The TMGB shall be connected to building steel if existing within room with an insulated #3/0 AWG (120mm²) stranded grounding conductor.
- D. Telecommunications Grounding Bus (TGB):
 - 1. Install in all low voltage or communication rooms. Refer to Technology drawings for exact locations.
 - 2. Install bus on insulated spacers 1-inch (25 mm), minimum, from wall and 12-inches (300 mm) above finished floor, unless otherwise indicated.
 - 3. The TGB shall be connected to the TMGB bus via the TBB with an insulated #3/0 AWG (120mm²) stranded grounding conductor installed in continuous conduits.

4. The TGB shall be connected to the nearest AC electrical panel ground bus with an insulated #3/0 AWG (120mm²) stranded grounding conductor installed in continuous conduits.
5. The TGB shall be connected to building steel if existing within room with an insulated #3/0 AWG (120mm²) stranded grounding conductor.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2, TIA and BICSI grounding requirements
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

3.3 EQUIPMENT AND COMPONENT GROUNDING

- A. Install insulated equipment grounding conductors to all telecommunications equipment and components.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70, NEMA, ANSI, TIA and BICSI:
 1. Armored and metal-clad cable sheaths.
 2. Equipment Cabinets and Racks.
 3. Cable trays and ladder racks.
 4. Conduits sections and conduit sleeves.

5. Equipment and Power Supply Enclosures.
6. Wall mounted cable terminals.
7. Other metallic components as necessary.
8. ESD Flooring

3.4 EXAMINATION

- A. Examine areas and conditions under which telecommunications grounding and bonding connections are to be made and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.5 INSTALLATION OF TELECOMMUNICATIONS GROUNDING AND BONDING SYSTEMS

- A. General: Install telecommunications grounding and bonding systems in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.
- B. Labeling:
 1. The final labeling scheme shall be coordinated with Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.
 2. Refer to Specification Section 27 05 00 for additional requirements that shall be fulfilled as part of this specification section.
- C. Coordinate with other electrical and telecommunications work as necessary to interface installation of telecommunications grounding and bonding system work with other work.
- D. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- E. Ground Rods: Drive rods until tops are 2-inches (50 mm) below finished floor or final grade, unless otherwise indicated.
 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

- F. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
 - 3. Coordinate with flooring contractor prior to installation for proper installation of bonding straps installed during the flooring installation.
- G. Install all connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.
- H. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- I. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.
- J. Install all connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

3.6 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

END OF SECTION 27 05 26

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an “end-to-end” solution is provided by one of the “pre-approved” manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish “benchmark” products from one or more of the “pre-approved manufacturers”. The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
 - a. Chatsworth-CPI
 - b. General Cable
 - c. Panduit
 - d. Southwire

Table 1 - Telecom Grounding Components			
Item	Part Name/Description	Manufacturer	Part Number
1	Telecom Grounding Busbar - 4"W x 20"L	Chatsworth-CPI	40153-020
		Legrand / Ortronics	GB4X20TMGB
		Panduit	GB4B0624TPI-1
2	Compression Lugs - #6AWG	Chatsworth-CPI	40162-951
		Legrand / Ortronics	CL2LB6A
		Panduit	LCC6-14JAW-L
3	C-Type Compression Taps	Chatsworth-CPI	40163-059
		Legrand / Ortronics	CTHD4666
		Panduit	CTAP4/0-4/0-X
4	3/0 Grounding Conductor (Green)	Southwire	GN:556123
		*Other	Submit for approval
5	#6 AWG Bonding Conductor (Green)	Southwire	GN:204974
		*Other	Submit for approval

Table 1 - Telecom Grounding Components			
Item	Part Name/Description	Manufacturer	Part Number
6	Ground Strap	Chatsworth-CPI	40159-009
		Legrand / Ortronics	GS-8
		Panduit	GACBJ

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	EXPLANATION
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 27 05 33 - TELECOMMUNICATIONS RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Product Appendix: There is no product number appendix for this section. Submit proposed raceway products as described within this specification and on the Technology Drawings.
- B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.
- C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.
- D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.
- E. Division 26 Basic Electrical Materials and Methods section.
- F. Division 26 Raceway and Boxes section for conduit connectors, fittings, and couplings.
- G. Division 7 Section "Firestopping" for conduit penetrations through rated walls and slabs.

1.2 SUMMARY

- A. Drawings are diagrammatic. All bends, boxes, fittings, couplings are not necessarily shown. Supply as necessary to comply with the National Electric Code.
- B. This Section includes raceways for Communications and Security cabling. Types of raceways, boxes and fittings in this section include the following:
 - 1. Electrical metallic tubing (EMT).
 - 2. Intermediate metal conduit (IMC).
 - 3. Rigid non-metallic conduit (RNC)
 - 4. High-density Polyethylene conduit (HDPE)
 - 5. Outlet boxes.
 - 6. Junction boxes.
 - 7. Pull boxes.
 - 8. Bushings.
 - 9. Locknuts.
 - 10. Knockout closures.

1.3 SUBMITTALS

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.
- B. Product Data: This section does not have a “benchmark” product Appendix; thus, Contractor shall submit product data for all applicable products as required per Technology Drawings including, but not limited to:
 - 1. Raceways and fittings.
 - 2. Wireways and fittings.
 - 3. Boxes and fittings.
- C. Installation Instructions: Manufacturer’s written installation instructions for wireway, surface raceway, and nonmetallic raceway products.

1.4 QUALITY ASSURANCE

- A. In addition to Section 27 05 00 requirements, the following shall apply to this specification section.
 - 1. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
 - 2. NEMA Compliance: Comply with applicable requirements of NEMA Std’s/Pub No.’s OS1, OS2 and PUB 250 pertaining to outlet and device boxes, covers and box supports.
 - 3. Federal Specification Compliance: Comply with applicable requirements of FS W-C 586, “Electrical Cast Metal Conduit Outlet Boxes, Bodies, and Entrance Caps.”

PART 2 - SYSTEM REQUIREMENTS

2.1 METAL CONDUIT AND TUBING

- A. Electrical Metallic Tubing (EMT) and Fittings: ANSI C80.3.
 - 1. EMT shall be used for standard device outlet raceway, unless otherwise noted.
 - 2. EMT shall be used for backbone conduit sleeves stubbed through floors.
- B. Intermediate Metallic Conduit (IMC) and Fittings:
 - 1. IMC shall be used for device outlets mounted below 10-ft in high traffic areas such as garages, loading docks, service tunnels, etc.
 - 2. IMC shall be used for extending service entrance cable from building point of entrance to termination or transition point when the distance exceeds 50 feet.

2.2 NONMETALLIC CONDUIT AND DUCTS

- A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.
 - 1. RNC shall be used for all permanent underground incoming service and/or “campus” backbone conduits to additional buildings.
- B. High-Density Polyethylene (HDPE) Conduit and Tubing Fittings: Schedule 40 or 80, NEMA TC 7; match to conduit or conduit/tubing type and material.
 - 1. HDPE shall be used for all temporary underground incoming service and/or “campus” backbone conduits to additional buildings.
 - 2. Conduit shall be smooth outer wall and ribbed inner wall design.
- C. Conduit, Tubing and Duct Accessories: Types, sizes and materials complying with manufacturer’s published product information. Mate and match accessories with raceway.
- D. Electrical non-metallic tubing (ENT): NEMA TC13 and UL1653.

2.3 CONDUIT BODIES AND FITTINGS

- A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching covers with gaskets secured with corrosion-resistant screws.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways. Use conduit bodies conforming to UL514B.
- C. EMT Conduit Bodies: Use bodies with steel set screw connectors and couplings for interior applications and steel compression gland connectors and couplings for exterior applications.
- D. HDPE: Use nonmetallic conduit bodies conforming to UL651A.
- E. Bushings: Insulated type, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system, for rigid steel conduit, IMC and EMT, larger than 3/4-inch size.
- F. Expansion Fittings: Each conduit that is buried in or secured to the buildings construction on opposite sides of a building expansion joint and each long run of exposed conduit that may be subject to excessive stresses shall be provided with an expansion fitting. Expansion fittings for rigid steel conduit shall be hot-dipped galvanized malleable iron with factory installed packing and a grounding ring. Expansion fittings for rigid non-metallic conduit shall be of the short type in runs 25-feet (7.6m) or less, and the long type in runs 26 to 80-feet (7.9 to 24.3m). The long type shall be a two piece barrel and piston joint, providing 6-inch (150mm) of the total movement range in 3/4-inch (19-mm)through 6-inch (150mm)” conduit sizes. The short type shall be a one piece, coupling with O-ring, providing 2-inch (50mm) of total movement range in 3/4 to 2-inch (19 to 50mm) conduit sizes.

- G. Seal Off Fittings: Threaded, zinc or cadmium coated, cast or malleable iron type for steel conduits. Fittings used to prevent passage of water vapor shall be of the continuous drain type.

2.4 FABRICATED MATERIALS - BOXES

- A. Device Outlet Back-Boxes: Provide galvanized flat rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes (two-gang, 4 11/16-inch x 4 11/16-inch 2 1/8-inch deep (120mm x 120mm x 54mm)), including box depths as required, suitable for installation at respective locations. Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.
1. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.
 2. Outlet Box Device Covers: Provide box covers as an individual component. In no instance shall a pre-fabricated box with a fixed box cover be utilized. All device covers shall be inter-changeable in the field based on openings requirements at respective locations. Box covers shall not be used as the box mounting bracket or as the mounting mechanism.
- B. Rain-tight and Weatherproof Outlet Boxes: Weatherproof devices shall be provided at all exterior locations and any location susceptible to water and other exterior conditions. Provide corrosion-resistant cast-metal rain-tight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening telecommunications conduit, cast-metal and plastic face plates with spring-hinged watertight covers (polycarbonate) suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners. Watertight cover shall allow for patch cords to be plugged in and sealed while in operation.
- C. Junction and Pull Boxes: Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers. Pull boxes installed in finished spaces must be flush mounted cabinets provided with trim, hinged door and flush latch and lock to match flush mounted panel board trim. Exact size

shall meet minimum industry standards based on conduit quantities and stacking arrangement, as indicated in the table below:

Conduit Trade Size mm (in)	Width mm (in)	Length mm (in)	Depth mm (in)	Width Increase for Additional Conduit mm (in)
27 (1)	101 (4)	406 (16)	76 (3)	51 (2)
35 (1-1/4)	152 (6)	508 (20)	76 (3)	76 (3)
41 (1-1/2)	203 (8)	686 (27)	101 (4)	101 (4)
50 (2)	203 (8)	914 (36)	101 (4)	127 (5)
63 (2-1/2)	254 (10)	1067 (42)	127 (5)	152 (6)
78 (3)	305 (12)	1220 (48)	127 (5)	152 (6)
91 (3-1/2)	305 (12)	1370 (54)	152 (6)	152 (6)
100 (4)	381 (15)	1525 (60)	203 (8)	203 (8)

D. Exterior junction or pull boxes, flush with grade:

1. Junction or pull box to be mounted flush with grade shall be polymer composite raintight with screw cover lids. Minimum box dimensions shall be 30-inch W x 60-inch L x 24-inch D (750mm x 1500mm x 600mm) or as indicated on the drawings. Exact size shall be provided to meet industry standards based on conduit quantities and stacking arrangement. Covers shall be polymer composite suitable for pedestrian traffic secured to box with stainless steel screws. Box to be furnished with continuous neoprene gasket to seal cover. Conduit entry shall be on side of box with bell ends.

E. Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

2.5 FIRESTOPPING - UL 1489

- A. Provide firestopping pillows, bricks or putty as required in all conduit openings to maintain rating of the wall. Fireproofing shall consist of ready to use, intumescent fibrous material enclosed in a strong polyethylene envelope. Contractor shall assume this is to be included in the raceway scope of work, unless directed otherwise by the Construction Manager and/or General Contractor.

PART 3 - EXECUTION

3.1 WIRING METHOD

- A. Outdoors: Use the following installation methods:
 - 1. Exposed: Intermediate metal conduit.
 - 2. Concealed: Intermediate metal conduit.
 - 3. Underground, Single Run: Rigid non-metallic conduit. PVC coated GRC 90° elbows.
 - 4. Underground, Grouped: Rigid non-metallic conduit. PVC coated GRC 90° elbows.
 - 5. Temporary: HDPE PVC Sch40/80.
- B. Indoors: Use the following installation methods:
 - 1. Exposed (below 10 ft. to floor): Intermediate metal conduit
 - 2. Exposed (above 10ft. or in electrical room): Electrical metallic tubing.
 - 3. Concealed: Electrical metallic tubing.
 - 4. Service entrance extension beyond 50-feet: Intermediate metal conduit.

3.2 INSTALLATION OF RACEWAYS

- A. General: Install telecommunications raceways in accordance with manufacturers' written installation instructions, applicable requirements of NEC, NEMA, ANSI, TIA, BICSI, and as follows.
- B. Labeling:
 - 1. The final labeling scheme shall be coordinated with Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.
 - 2. Refer to Specification Section 27 05 00 for additional requirements that shall be fulfilled as part of this specification section.
- C. Clearances: Telecommunications raceway shall be routed to maintain appropriate clearances from potential interfering electrical sources per NEC, NEMA, ANSI, TIA, and BICSI requirements. Provided below are minimum requirements of key components that shall be maintained. For any instances where field conditions do not allow for the minimum clearances, the Contractor shall notify the Architect and Engineer so that an acceptable solution can be coordinated.
 - 1. 120V Power Conduits: 6-inches (150mm)
 - 2. 208V and Higher Power: 24-inches (600mm)
 - 3. Lighting System: 12-inches (300mm)
 - 4. Transformers: 48-inches (1200mm)
 - 5. Motors and Fans: 48-inches (1200mm)

6. Other Interfering Sources to be field verified and coordinated by Contractor with Architect and Engineer.
- D. Unobstructed Cabling Pathways:
1. Raceway installer shall provide conduit sleeves through all walls and continuous segments above inaccessible ceiling spaces to ensure unobstructed cable pathways are provided from each device location back to the appropriate HC. (Refer to Technology Drawings for additional information.)
- E. Horizontal Distance Limitations:
1. Communications horizontal cabling shall not exceed a total cable length of 295-feet (90m) for the permanent basic link. The channel length shall not exceed 325-feet (100m) when patch cords are installed.
 2. Contractor(s) responsible for providing the communications horizontal raceway shall ensure that unobstructed pathway to each device location does not cause cable to exceed 295-feet (90m) length from to the nearest horizontal cross-connect (HC) location. This may require unobstructed pathway to be no more than 250-ft (76m) to accommodate necessary cable slack. Contractor shall bring any distance concerns to the attention of the Architect and Engineer during the bid process and/or at a minimum during the shop drawing process, prior to installation.
- F. Telecommunications conduits shall maintain large bends and sweeps. Provided below are the ratios for minimum conduit bend radius to conduit size diameter.
1. Smaller than 2-inches (50mm) : 6:1
 2. 2-Inches (50mm) and Larger: 10:1
- G. Conceal conduit and EMT, unless indicated otherwise, within finished wall, ceilings, and floors. Keep raceways at least 6-inches (150mm) away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.
- H. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping.
- I. Complete installation of telecommunications raceways before starting installation of conductors within raceways.
- J. Provide supports for raceways as specified elsewhere in Electrical and/or Communications specification sections and in accordance with NEC and local authorities' seismic requirements.
- K. Prevent foreign matter from entering raceways by using temporary closure protection.
- L. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab. All elbow penetration through the slab shall be PVC coated rigid metallic conduit Ells.

- M. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
- N. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings except as otherwise indicated.
- O. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.
- P. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. All exposed conduit runs shall be approved by the Architect prior to installing.
- Q. All exposed conduits in public areas shall be painted to match surrounding walls. Verify exact color with the Architect. Painting specified herein shall be provided by others.
- R. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. All exposed conduit routing shall be approved by the Architect prior to installing.
- S. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Use expansion fittings at building expansion joints.
- T. Tighten set screws of threadless fittings with suitable tool.
- U. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside of the box. All conduit connections to junction boxes shall have insulated bushings.
- V. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
- W. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave no less than 12 inches of slack at each end of the pull wire.

- X. Telecommunications raceways shall have a maximum pulling length of 100 feet and a maximum of two 90° bends or equivalent. A pull-box or junction-boxes shall be provided where necessary to comply with these requirements.
- Y. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
 - 1. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces, air-conditioned spaces and walk-in coolers.
 - 2. Where required by the NEC.
- Z. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs flush with floor.
- AA. Flexible connection: Use flexible conduit with a maximum length of 6-feet (3m) for furniture feeds. Use liquid-tight flexible conduit in wet locations. Install separate equipment grounding conductor across flexible connections.
- BB. PVC externally coated rigid steel conduit: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.
- CC. All underground conduits shall be installed a minimum of 24-inches (600mm) below finish grade or below frost line, whichever is deeper.
- DD. Telecommunications service entrance cables that extend beyond 50-feet from the building point of entrance shall be in IMC from the point of entrance to the point of termination without breaks as require by the NEC.
- EE. Daisy Chaining of pathways shall not be allowed unless specifically noted on the drawing or detailed on drawings. Each backbox shall be installed with a dedicated pathway. Any proposed or required daisy chaining will be detailed in contractor shop drawings and submittals and approved prior to installation. Any remediation to dedicated pathways as required will be the total responsibility of the Contractor at no additional cost to Owner.
- FF. Provide pedestrian walk over guards for all temporary surface conduit routed in pedestrian zones.

3.3 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

- A. General: Install electrical boxes and fittings in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
- C. Provide rain-tight or weatherproof covers for all communications device outlets at all interior and exterior locations exposed to weather or moisture.
- D. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- E. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.
- F. Installing boxes back-to-back in walls shall not be permitted. Provide no less than 12-inches (150mm) of separation.
- G. Position recessed outlet boxes accurately to allow for surface finish thickness.
- H. Do not use round boxes where conduit must enter box through side of box, which would result in difficult and unsecure connections when fastened with locknut or bushing on rounded surfaces.
- I. Fasten telecommunication and electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embedded electrical boxes in concrete or masonry.
- J. Exterior junction or pull boxes shall be mounted flush with grade, unless noted otherwise or indicated to be above ground on the drawings. Boxes shall be surrounded on all sides with 6 inches minimum of concrete. Top of concrete shall flush with grade. Seal all conduit entries into box with duct seal to prevent entrance of moisture, after conductors are installed.
- K. Tap and splices, where permitted by these specifications within exterior junction boxes, shall be performed with an encapsulating watertight splice or tap kit which insulates and moisture seals the connection. Kit shall consist of the appropriate size and type mold, encapsulating resin and end sealing tape.
- L. Subsequent to installation of boxes, protect boxes from construction debris and damage.
- M. Outlet back-boxes shall be installed straight on walls to provide a neat appearance of faceplates on finished walls.

3.4 GROUNDING

- A. Upon completion of installation work, properly ground telecommunications boxes and demonstrate compliance with requirements.

3.5 ADJUSTING AND CLEANING

- A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris.

END OF SECTION 27 05 33

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an “end-to-end” solution is provided by one of the “pre-approved” manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish “benchmark” products from one or more of the “pre-approved manufacturers”. The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
 - a. Abesco
 - b. Hilti
 - c. STI

Table 1 - Fire Stopping			
Item	Part Name/Description	Manufacturer	Part Number
1	EZ Path Smoke pathway *Sizes per drawings (4"x4")	STI	NEZ44 *Others as applicable
2	Flexible Firestop Block	Hilti	CFS-BL
3	Cable Transit Firestop Device - Round *Sizes per drawings (2" dia, 4" dia)	Abesco	31938, 31950 *Others as applicable
4	Cable Transit Firestop Device - Square *Sizes per drawings (2.5", 4")	Abesco	31940, 31942 *Others as applicable

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	EXPLANATION
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 27 05 36 - CABLE TRAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Product Appendix: Refer to Appendix 1, Equipment Schedules, for specific product information on the benchmark products. These equipment schedules should be the baseline for product data submittals, but are not intended to be an all-encompassing bill of materials.
- B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.
- C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.
- D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.
- E. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.

1.2 SUMMARY

- A. Extent of cable tray system work is indicated by drawings. Cable trays are defined to include, but not limited to, supports, straight sections, reducers, bends, tees, crosses, elbows, covers, dividers and other applicable accessories.
- B. Types of cable tray systems required for project include the following:
 - 1. Wire Basket type.
 - 2. Horizontal and Vertical cable runway routed within Communications Rooms is specified in specification section 27 11 00.

1.3 SUBMITTALS

- A. General Description and Requirements
 - 1. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.
- B. Product Data:
 - 1. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

C. Shop Drawings and As-Built Drawings shall include:

1. Floor Plans: Provide scaled building floor plan drawings (with current reflected ceiling plan layer shown) based on architectural background indicating installation of cable tray systems and accessories including clamps, brackets, hanger rods, splice plate connectors, expansion joint assemblies and fittings. Plans shall show accurately scaled components, mounting heights/elevations, and spatial relationships (clearances) to adjacent structure and equipment, including but not limited to, HVAC ductwork, piping, and light fixtures. Shop drawings shall clearly indicate areas with cable tray clearance limitations and/or other cable access limitations for review and approval by Owner, Architect, and Engineer.
2. Details: Submit cable tray support detail drawings indicating installation of cable tray systems and accessories including clamps, brackets, hanger rods, splice plate connectors, expansion joint assemblies and fittings, and all grounding components.
3. Documentation: Provide submittals and documentation as required by the project manual (in addition to electronic copies) for review or as indicated in Division 1 general conditions.

PART 2 - SYSTEM REQUIREMENTS

2.1 CABLE TRAY SECTIONS AND COMPONENTS

- A. General: Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units; capable of supporting concentrated loads at any given point and maximum deflection of 1-inch (25mm) at full cable load, also indicated below. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features:

1. Wire Basket Type
 - a. Tray Material: ASTM A510 high strength steel wires.
 - b. Cross Rungs: Standard 2-inch (50mm) x 4-inch (100mm) wire mesh pattern.
 - c. Bends and Fittings: 24-inch (600mm) minimum radius.
 - d. Construction: 2-inch (50mm) deep Steel wire side flanges and rounded wire ends.
 - e. Tray Finish: ASTM B 633 Electro zinc (Interior Locations) and ASTM Type 304 L stainless steel passivation per ASTM A380 (Exterior, Wet, and Corrosive Locations).
 - f. Lengths shall not exceed 10'-0" (3.0m).
 - g. Loading Criteria: Cable tray supports shall be provided per manufacturer recommendations to meet the following minimum loads:
 - 1) Point Load Rating: 50-lb (0.23 kN) at any given point.
 - 2) Continuous Load Rating: 50-lb/ft (0.75 kN/m).

- h. Supports: Cable tray supports shall be provided for each section and/or fitting and shall comply with NEMA VE-2 installation guidelines for maximum distance from support to the end of each section and/or fitting. Aircraft cable shall not be permitted as a means of supporting cable tray. Additionally, cable tray shall not be supported with center mount trapeze supports.

2.2 CABLE TRAY ACCESSORIES

- A. Provide all necessary cable tray accessories as per manufacturer recommendations including, but not limited to, items described below and or indicated within cable tray details.
- B. Provide all grounding and bonding components including, but not limited to, conductors, jumpers, clamps, etc. as recommended by cable tray manufacturer in order to maintain electrical continuity in the cable tray system.
- C. Provide dropouts (waterfalls), conduit adapters, hold-down devices and blind ends, as indicated, and as recommended by cable tray manufacturer. Dropouts shall be provided for all cable tray segments that provide a vertical cable transition point (i.e., where cable tray dead-ends into a Communications Room, transitions to vertical cable tray, transitions to horizontal cable tray at a different elevation, etc.).
- D. Provide pull-strings through any cable tray segment that has limited clearance accessibility, to ensure cables can be installed. Pull-strings shall be provided for each section when cable tray dividers are provided.

2.3 SUPPORTS AND CONNECTORS

- A. Provide all necessary cable tray support mechanisms as per manufacturer recommendations including, but not limited to, items described below and or indicated within cable tray details.
- B. Provide cable tray supports and connectors as indicated within cable tray details, including but not limited to, uni-strut, trapeze mount threaded rods, wall mounted cantilever brackets, threaded rod protective sleeves, bonding jumpers, etc.

2.4 FIRESTOPPING - UL 1489

- A. Provide firestopping pillows and/or bricks as required in all cable tray openings to maintain rating of the wall. Fireproofing shall consist of ready to use, intumescent fibrous material enclosed in a strong polyethylene envelope. Contractor shall assume this is to be included in the cable tray scope of work, unless directed otherwise by the Construction Manager and/or General Contractor.

PART 3 - EXECUTION

3.1 INSTALLATION OF CABLE TRAY SYSTEMS

- A. Install cable trays in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that cable tray equipment complies with requirements. Comply with requirements of NEC 392, and applicable portions of NFPA 70B and NECA's "Standard of Installation" pertaining to general electrical installation practices.
- B. All walls where cable tray is installed with wall mounted brackets shall be internally reinforced as necessary at all bracket locations to support cable tray loads. Contractor shall coordinate this with the applicable trades in addition to the Architect and Engineer, prior to installing supports and/or cable tray at these locations.
- C. Labeling:
 - 1. The final labeling scheme shall be coordinated with Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.
 - 2. Refer to Specification Section 27 05 00 for additional requirements that shall be fulfilled as part of this specification section.
- D. Coordinate with other low voltage, electrical, and mechanical work as necessary to properly interface installation of cable tray work with other work.
- E. Accessibility Clearances: Coordinate and provide cable tray clearances as indicated within the cable tray details and these specifications, to allow for appropriate accessibility for initial and future cable installation. Coordinate location of cable trays with all other trades to ensure clearances are obtained. For any instances where field conditions do not allow for the minimum clearances, the Contractor shall notify the Architect and Engineer so that an acceptable solution can be coordinated.
 - 1. 6-12" W x 2" D Wire Basket Tray (Minimum Clearances):
 - a. Side Access: 18" clearance on one side
 - b. Top Access: 6" clearance above tray for continuous segments.
 - 2. Exceptions: Cable tray segments may have limited clearances at intermittent crossings with structure or MEP systems. The following guidelines shall apply for such cases, provided there is clear access at both sides/ends of the conflict zone:
 - a. For areas where conflict zones span up to an 8'-0" segment of tray, clearances of 6" between the top of the cable tray rail and the structural or MEP system will be permitted
 - b. For areas where conflict zones consist of a beam, duct, conduits, or pipes crossing over a short segment of tray (3'-0" or less), clearances of 2-3" between the top of the cable tray rail and the structural or MEP system will be permitted.

- c. All other major cable tray conflict zones which may prevent the Contractor from maintaining appropriate cable tray clearances shall be reviewed with the Owner, Architect, and Engineer during the submittal process.
- F. Electrical Clearances: Telecommunications raceway shall be routed to maintain appropriate clearances from potential interfering electrical sources per NEC, TIA, and BICSI requirements. Provided below are minimum clearance requirements of key components that shall be maintained.
 - 1. 120V Power Conduits: 6-inches (150mm)
 - 2. 208V and Higher Power: 12-inches (300mm)
 - 3. Lighting System: 12-inches (300mm)
 - 4. Transformers: 48-inches (1200mm)
 - 5. Motors and Fans: 48-inches (1200mm)
 - 6. Other Interfering Sources to be field verified and coordinated by Contractor with Architect and Engineer.
- G. Cable Tray Grounding:
 - 1. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526.
 - 2. Cable trays with powder-coat paint should have coating mask completely removed at factory supplied grounding locations, and be spliced with listed connectors per manufacturer recommendation.
 - 3. Electrically ground cable trays and ensure continuous electrical conductivity of cable tray system in accordance with manufactures instructions. Provide maximum of 1.0 ohms resistance to building ground connection. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground.
- H. Support cable tray per manufacturer recommendations to accommodate the loading criteria as indicated within this specification.
- I. Provide UL listed "Firestopping" for all cable tray penetrations through fire rated walls and slabs according to Division 07 Section "Penetration Firestopping". Install E90 certified cable tray for critical circuits, hallways, or in areas of egress as shown in drawings. Refer to Division 7 for additional requirements.
- J. Wall openings that cable tray passes through that don't require Firestopping per code shall be stopped or sealed to maintain the building envelope and/or acoustical requirements. Refer to architectural floor plans, details and specifications for additional requirements.
- K. Remove burrs and sharp edges of cable trays, wherever these could possibly be injurious to wiring insulation or jacketing.

3.2 TESTING

- A. Test cable trays to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. Submit results to Engineer for approval.

3.3 WARNING SIGNS

- A. After installation of cable trays is completed, install warning signs, either on or in proximity of cable trays, where easily seen by occupants of space, and indicating warning with following wording, "WARNING! NOT TO BE USED AS WALKWAY." Provide 1-1/2"-high yellow lettering on black background, of style selected by Architect/Engineer. Temporary signage shall be installed during installation to notify other contractors that the tray shouldn't be used as a walkway.

END OF SECTION 27 05 36

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an “end-to-end” solution is provided by one of the “pre-approved” manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish “benchmark” products from one or more of the “pre-approved manufacturers”. The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
 - a. B-Line by Eaton
 - b. Cablofil Legrand
 - c. PW Industries Legrand
 - d. MP Husky

Table 1 - Cable Tray (Wire Basket Type)			
Item	Part Name/Description	Manufacturer	Part Number
1	Wire Basket Tray - 4" deep	Eaton / B-Line	FT4X--X10
		Legrand / Cablofil	CF105/XXXEZ
		Panduit	WG8BL10 + WGSW4BL
3	Horizontal / Vertical Bend Fitting Kits	Eaton / B-Line	WASHER SPL KIT
		Legrand / Cablofil	CE40EZ + WASHER-EZ
		Panduit	WGHRDWKTBL
4	Cable Tray Drop-Out (Waterfall), Aluminum	Eaton / B-Line	DROP OUT
		Legrand / Cablofil	CABLEXIT
		Panduit	WGSWF4BL
5	Cable Tray Dividers, Aluminum (Straight / Flexible / etc.)	Eaton / B-Line	4 IN DIVIDER 6 IN DIVIDER
		Legrand / Cablofil	COT105 KITPG COT150 KITPG
		Panduit	WGDW4PG
6	Cable Tray Grounding Components	Eaton / B-Line	GROUND BOLT
		Legrand / Cablofil	GNDSB
		Panduit	GACBJ6 GB2B03

Table 1 - Cable Tray (Wire Basket Type)			
Item	Part Name/Description	Manufacturer	Part Number
7	Miscellaneous Components (Expansion / Splice plates, etc. as applicable)	Eaton / B-Line	WASHER SPL KIT *Others as applicable
		Legrand / Cablofil	EDRNEZ
		Panduit	WGSPL1218BL
		MonoSystems	TM-CPL-JN3-XX
8	Cable Tray Support Components (as applicable)	Eaton / B-Line	WB46H, FTBXXCT *Others as applicable
		Legrand / Cablofil	FASP
		Panduit	WGCB12BL

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

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Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	EXPLANATION
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 27 05 43 - UNDERGROUND DUCTS, RACEWAYS AND MANHOLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Product Appendix: There is no product number appendix for this section. Submit proposed raceway products as described within this specification and on the Technology Drawings.
- B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.
- C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.
- D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.
- E. Division 3 Concrete
- F. Division 26 Basic Electrical Materials and Methods section
- G. Division 27 Telecommunications Grounding and Bonding
- H. Division 27 Telecommunications Raceways and Boxes
- I. Division 31 Earthwork

1.2 SUMMARY

- A. Provide all necessary components including, but not limited to, conduits, manholes and grounding for telecom service entrance from property line to each demarcation/main communications room.
- B. Drawings are diagrammatic. All bends, fittings, and couplings are not necessarily shown. Supply as necessary to comply with the National Electric Code.
- C. Furnish all labor, materials, tools, equipment, and services for all underground service and manholes as indicated, in accordance with provisions of Contract Documents.
- D. Completely coordinate with work of all other trades.

1.3 SUBMITTALS

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.
- B. Product Data: This section does not have a “benchmark” product Appendix, thus Contractor shall submit product data for all applicable products as required per Technology Drawings including, but not limited to:
 - 1. Manholes, Pull Boxes, Handholes.
 - 2. Duct bank materials, including spacers and miscellaneous components.
 - 3. Warning tape and tracer wire.
 - 4. Conduits.
 - 5. Inner-Ducts
- C. Shop drawings:
 - 1. Site plan: Provide complete site plan showing all existing and proposed utilities. Manholes, handholes, and major raceway 2-inches and larger shall be indicated. Shop drawings shall represent final conduit routing and manhole/handhole placement as coordinated with Service Provider, Civil Engineer, and other applicable trades.
 - 2. Details:
 - a. Duct bank sections: Provide duct bank section drawing for each unique length of trench.
 - b. Manholes, Pullboxes, Handholes: Provide details indicating:
 - 1) Conduit size and entry locations
 - 2) Cover design
 - 3) Racking type and locations
 - 4) Grounding details
 - 3. One-Line Drawings: Provide one-line drawings indicating connection to existing site infrastructure.
- D. Test reports as required for compaction and concrete work in Division 3 and 31.

1.4 QUALITY ASSURANCE

- A. Manufacturer qualifications
 - 1. Provide products from manufacturers regularly engaged in the production of communications infrastructure components, including but not limited to, manholes, hand holes, and hardware.

2. Provide products from manufacturers whose products of similar types, capacities, and characteristics have been in satisfactory use in similar type projects for not less than five years.
- B. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.
- C. Compaction density test: ASTM D1557.
- D. Contractor will hire an independent soils laboratory to conduct in place moisture-density tests to ensure that all work complies with this specification.
 1. Notify Construction Manager or Owner's representative at least 2 weeks prior to anticipated date of testing.
 2. Contractor will pay additional cost if work is delayed due to his failure to notify Owner's agent as specified above.
- E. Comply with all aspects of "Safety Rules & Regulations for Excavation: as promulgated by the state in which excavation will occur.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver equipment and components in factory-fabricated containers or wrappings, which properly protect equipment from damage.
- B. Store conduit to avoid warping or deterioration with end caps.
- C. Store plastic conduit on flat surface protected from direct rays of sun.
- D. Handle equipment and components carefully to prevent damage. Do not install damaged units or components; replace with new.

1.6 SEQUENCING AND SCHEDULING

- A. All work shall be reviewed and coordinated with the Construction Manager and/or General Contractor prior to commencing.
- B. Coordinate installation with Civil, Structural, Electrical, and other trades to eliminate disruption and/or conflict with other systems (paving, curb and gutter, etc.).

1.7 PROJECT SITE CONDITIONS

- A. Prior to submitting a proposal, the Contractor shall inspect the Contract Documents, and shall become fully informed as to laws, ordinances, and regulations affecting the project. The Contractor shall immediately bring to the Owner, Architect, and Engineer's attention, in

writing, any existing condition or statute that contradicts, is in conflict with, or negates the Contract Documents. Failure of the Contractor to become fully informed as to all above mentioned items shall in no way relieve the Contractor from any obligations with respect to their proposal.

- B. The Technology Drawings depict equipment locations and conduit runs in a schematic manner. Field conditions and coordination with related trades may warrant relocations of field devices. No additional compensation will be allowed due to these revisions.

1.8 WARRANTY

- A. The manufacturer shall provide a warranty with a minimum term of 25-years for all structures and components. This warranty shall cover all components including manholes, handholes, racking, etc. to maintain the specified performance, physical criteria, and applications assurance. Any such components shall be replaced by the Manufacturer at no cost to Owner during this period. The Contractor and Manufacturer shall submit all information and documentation on Warranty.
- B. A one (1) year warranty on the Work and Compaction shall be provided by the Contractor. If, within one (1) year after the date of final acceptance of the installation or within such longer period of time as may be prescribed by law or by the terms of any applicable special warranty required by the Contract Documents or provided by a manufacturer, any of the work or equipment is found to be defective or not in accordance with the Contract Documents, the Contractor shall correct it promptly including all parts and labor after receipt of notice from the Owner to do so unless the Owner has previously given the Contractor a written acceptance of such condition. This obligation shall survive termination of the contract. The Owner shall give such notice promptly after discovery of the condition. Such notice shall be provided by Owner representatives, to be identified, either verbally or in writing.
- C. Nothing contained in the Contract Documents shall be construed to establish a shorter period of limitation with respect to any other obligation which the Contractor might have under the Contract Documents or any manufacturer's warranty. The establishment of the time period noted above, after the date of final acceptance or such longer period of time as may be prescribed by law or by the terms of any warranty required by the Contract Documents, relates only to the specific obligation of the Contractor to correct the work or equipment, and has no relationship to the time within which his obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to his obligations other than specifically to correct the work or equipment.
- D. If system operation is not fully restored during the warranty period within two (2) business days, the Owner reserves the right to require the Contractor to provide on-site manufacturer's service technicians at no additional cost.
- E. The Owner reserves the right to expand or add to the system during the warranty period using firm(s) other than the Contractor for such expansion without affecting the Contractor's

responsibilities, provided that the expansion is done by a firm which is an authorized dealer or agent for the equipment of system being expanded.

1.9 SPECIFICATION RESPONSE

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

1.10 DEFINITIONS

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

PART 2 - PRODUCTS

2.1 DUCT SYSTEM

- A. Duct System: Multiple and single, conduits completely encased in concrete.
 - 1. Separators: Plastic or other non-metallic, non-decaying material.
 - 2. Inner-Ducts: Provide (3) inner-ducts in each conduit as indicated on Technology Drawings.
- B. Pull Wire: No. 9 galvanized iron, or heavy nylon cord, free of kinks and splices.
 - 1. Marked with length every 10'.
- C. Detectable Warning Tape:
 - 1. Polyethylene plastic warning tape
 - a. Detectable warning tape can be used to provide tracer wire and warning tape only if conduits aren't encased in a concrete duct way. Concrete ductway shall include tracer and non-detectible warning tape.
 - b. 6" width and 10mm thick
 - c. Integral wires, foil backing or other means of detection up to 3' deep.
 - d. Tape to be orange in color and read "CAUTION, BURIED COMMUNICATIONS LINE BELOW" or as required by local code.

D. Non-detectable Warning Tape:

1. Polyethylene plastic warning tape
 - a. 6" width and 10mm thick
 - b. Tape to be orange in color and read "CAUTION, BURIED COMMUNICATIONS LINE BELOW" or as required by local code.

E. Tracer Wire:

1. #6 AWG bare copper wire.

2.2 HANDHOLES

A. Telecommunications Handholes: Sizes as indicated on drawings:

1. Concrete: 4500 PSI. Conform to Division 3 requirements.
2. HS-20 rated for traffic rated conditions.
3. Cover and frame: 36" diameter, gray cast iron with machine finished seat for perfect joint between cover and frame. "COMMUNICATIONS" to be stamped on cover.
4. Provide floor drain with grate.
5. Provide accessories per Telecommunication drawings.

B. Cable Pulling Irons: Galvanized, mounted on wall.

1. 7/8-inch diameter installed 3" to 9" above the floor and embedded in wall during construction.

C. Cable Racks: Galvanized, mounted on wall.

1. Provide minimum (3) cable racks on each long wall with minimum of 8 adjustable hooks; minimum 2 spare hooks on each rack.
2. Insulators: Best quality, high glazed porcelain; provide for each hook.
3. Space racks so each end of splices is supported horizontally.

D. Ladder: Galvanized.

1. Each manhole and handhole to contain its own ladder.

E. Sump Pit:

1. Provide 12" diameter by 24" deep sump recess with removable perforated grate. Refer to Division 31 for base course material.

F. Grounding:

1. Refer to Section 27 05 26 for requirements that shall be fulfilled as part of this specification section.

PART 3 - EXECUTION

3.1 INSTALLATION OF HANDHOLES

- A. Determine exact location of each manhole after careful consideration has been given to location of other utilities, grading, and paving.
 1. Do not begin construction until location of each manhole has been reviewed by Architect/Engineer.
- B. Construct manholes and/or handholes of type indicated in accord with applicable details.
 1. Mix, place and cure concrete or set precast unit on non-expansive soil bed in accord with Division 3 and 31 requirements.
- C. Set frames and cover:
 1. Paint exterior with 2 coats asphaltic paint after inspection and before setting.
 2. Set top of manhole and/or handhole minimum 12" below finished grade to allow for soil amendments and planting or roadway surface. Coordinate with Civil Engineer for roadway surface section depth.
 3. In paved areas, set top of manhole covers flush with finished surface of paving.
 4. In unpaved areas, set top of manhole covers approximately 1/2" above finished grade.
 5. Where final grades are higher than top of manhole, install sufficient number of courses of grade rings between top of manhole and manhole frame to elevate manhole cover to final grade level.
- D. Install cable racks, ladder and cable pulling irons.
- E. Provide ground rods, bonding ribbon, and ground wires per Section 27 05 26.

3.2 DUCT BANK

- A. Form all duct banks in square or rectangular fashion as shown. Install duct spacers per manufacturer's requirements.
- B. Pitch conduits a minimum 1:300 down towards manhole and/or handhole and away from building. Slope conduits from a highpoint midway between manholes.

- C. Install tracer wire in top 2" of concrete encasement. Tracer wire shall be attached to the inside of the manhole near lid with sufficient slack to reach opening.
- D. Install warning tape 12" above top of duct bank.
- E. Adjust final slopes on-site to coordinate with utilities and structure.
- F. Backfill and compaction requirements per Division 31 requirements.
- G. After installation, clean and swab ducts.
- H. Install galvanized steel pullwires in spare ducts. Cap empty ducts with screw covers.
- I. Label conduit at stub-up and manhole penetrations in accordance with Section 27 05 00.

END OF SECTION 27 05 43

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an “end-to-end” solution is provided by one of the “pre-approved” manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish “benchmark” products from one or more of the “pre-approved manufacturers”. The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
 - a. Carlon
 - b. Eastern Wire + Conduit
 - c. Maxcell
 - d. Oldcastle

Table 1 - Outside Plant Infrastructure			
Item	Part Name/Description	Manufacturer	Part Number
1	Manhole Concrete 24"W x 72"L x 48"D	Oldcastle	2x6x4 Comm Vault
		*Other	Submit for approval
2	Standard Inner-duct (OSP) HDPE Single Wall with Pull Rope (1" or 1-1/4" dia per drawings)	Carlon	CF4X1C (1" dia.) CG4X1C (1-1/4" dia.)
		Carlon	DF4X1C (1" dia.) DG4X1C (1-1/4" dia.)
		Eastern Wire + Conduit	Kortech PDCN1000F
3	Fabric Mesh Inner-duct (3-cell for 4" conduit) - Alternate for (3) 1" OSP in 4" conduit	Maxcell	MXE86383
		*Other	Submit for approval
4	HDPE Conduit – SCH-40 reel conduit 2", 3" 4"	Duraline	SCH 40 Smoothwall

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	EXPLANATION
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FIT-OUT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Product Appendix: Refer to Appendix 1, Equipment Schedules, for specific product information on the benchmark products. These equipment schedules should be the baseline for product data submittals, but are not intended to be an all-encompassing bill of materials.
- B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.
- C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.
- D. Architectural, Structural, Mechanical, Electrical, and Technology Drawings. Other systems drawings may apply.
- E. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.
- F. Rough carpentry is specified in a Division 6 section.

PART 2 - SYSTEM REQUIREMENTS

2.1 COMMUNICATIONS ROOM FIT-OUT

- A. Communications Entrance Cabling Pathways
 - 1. Inner Duct
 - a. Provide (3) 1-1/4-inch (31mm) outside plant rated fiber optic inner ducts in one or more conduits as indicated on the site plan, for incoming Communications service cabling.
- B. Communications Backboard
 - 1. Plywood Backboard:
 - a. Provide 3/4-inch (19mm) AC grade plywood back board mounted on communications walls as noted on drawings.
 - b. Plywood shall be mounted "A" side out, "C" side to the wall.

- c. Shall conform to UL FR-S Plywood 1780 R-7003
 - 1) Shall be fire retardant impregnated plywood OR
 - 2) Plywood shall be painted with fire rated intumescent paint on all sides.
- d. Shall be painted to match architectural finish (white minimum), fire rated plywood must be painted with intumescent paint to maintain rating.
- e. Ensure that UL listing and Fire Rating stamp are left unpainted to allow inspector to verify the rating of the plywood.
- f. If the UL stamp is on the "C" side of the plywood, contractor shall document via install and material progress photographs, delivery manifests and UL listing certifications to help satisfy potential inspector comments.

C. Communications Cabinets, Racks, Frames and Enclosures

1. General

- a. Provide Equipment Cabinet and/or Rack types and sizes as shown on Technology Drawings. Refer to specific rack types described below for additional information.
- b. Cabinets and/or racks shall be completely setup and installed all locations.
- c. Cabinets and/or racks shall be vertically and horizontally level.
- d. Cable distribution equipment cabinets and racks shall utilize 19-inch Standard / ETSI wide rack system. Cabinets (if applicable) post depths shall be adjustable.
- e. Rack Rail Width: 3-inch (75mm).
- f. Rack Units: 42U (minimum).
- g. Rack Material: 6061-T6 Aluminum.
- h. Enclosure and/or Rack Finish: Black Epoxy Powder Coat.
- i. Rack Mounting Holes: Pre-drilled and Threaded Tap Holes (spacing and diameter) or 3/8-inch (9.5mm) Square Punch with Cage Nuts per TIA standard pattern.
- j. Vertical Cable Managers: Yes, as described within this specification.
- k. Horizontal Cable Managers: Yes, as described within this specification.
- l. Power Strips: Yes, as described within this specification.
- m. Bonding and Ground. Yes, all cabinets and racks shall be grounded as described within Technology Drawings and specifications.
- n. Cabinet Enclosure Electric Fan: Include as applicable per specified enclosure.

2. Equipment Racks – 2-post Cable Distribution and Network Type:

- a. Provide types and sizes as indicated on Technology Drawings.
- b. Equipment Cabinet and Rack Specifications:
 - 1) Enclosure: None.
 - 2) Rack Type: 2-Post open frame rack, 19-inch TIA Standard.
 - 3) Rack Size: 19" W x 84" H (42U) (483mm x 2100mm).
 - 4) Loading: 1000-lb (450kg).
 - 5) Mounting Type: Bolted to Floor with Neoprene Isolator.

D. Communications Termination Blocks and Patch Panels

1. All communications cables shall be terminated unless noted otherwise.
2. Cable terminations including wall fields, blocks, and patch panels are specified with in other sections.
3. Refer to 27 13 13 – Communications Copper Backbone Cabling, 27 13 23 – Communications Optical Fiber Backbone Cabling, and 27 15 01 – Communications Horizontal Cabling for additional requirements.

E. Communications Cable Management

1. General
 - a. Horizontal cable tray shall be mounted around room perimeter and above equipment racks as indicated on drawings. Tray sections shall be offset a minimum of 6-inches (150mm) clear from wall (unless otherwise noted) to allow passage of other systems up wall including risers, backbone, and other distribution.
 - b. Vertical ladder rack shall be placed on wall above riser conduit locations to support tie off of backbone cables.
 - c. Cable Tray sections shall be bonded together for electrical continuity (grounding) and system bonded to telecommunications ground bus (TGB) or electrical ground bus. Ladder rack, hardware, and components shall be UL classified.
 - d. Cable Tray drop-outs shall be provided above all equipment racks and/or cabinets to allow for cable transition to termination panels.
2. Cable Tray – Ladder Type
 - a. Cable racking in Communications Rooms shall be ladder rack with ASTM A513 and A570 structural tubular steel complete with all required mounting hardware and with all fittings and cables needed to form a bonded (grounded).
 - 1) Width: Refer to Technology Drawings.
 - 2) Side rails: 1½-inch x 3/8-inch (150mm x 9.5mm)
 - 3) Rungs: 9-inches (225mm) on-center
 - 4) Finish: Yellow zinc dichromate.
3. Wall Field Cable Managers:
 - a. Jumper troughs and cable managers shall be provided along each side and between wall fields or any other wall mounted cable terminals or patch panels. This is to provide adequate support of cables interconnecting wall fields or other wall mounted cable terminals.

4. D-Rings:

- a. D-Rings or equivalent means shall be provided as necessary on backboard to support any horizontal and vertical cables not supported by cable tray or other means.
- b. Spacing shall not exceed 24-inches (600mm) or cable manufacturer's recommendation, whichever is less.

F. Communication Rack Mounted Power Protection and Power Strips

1. Rack Mounted Uninterruptible Power Systems (UPS)

- a. A rack mounted UPS shall be provided by the project.
- b. The UPS including battery requirements, rack enclosure and power connections are specified within another section.

2. Vertical Power Strips

- a. One (1) equipment cabinet shall be installed with (2) different vertical power strips that have multiple power outlets to connect equipment within cabinet.
- b. Power strips shall have a cord with plug and shall be connected to specific receptacles on dedicated circuits; (1) L6-30P, (1) L5-20P.
- c. Power strips shall be connected to different power sources or UPS wherever possible.
- d. Provide mounting brackets per cabinet and/or power strip manufacturer recommendations to properly mount power strips within cabinet.
- e. There may be various power strip types and configurations used on this project. Refer to Technology Drawings and product list for additional requirements.

3. Horizontal Power Strips

- a. Five (5) equipment cabinets shall be installed with (2) different horizontal power strips that have multiple power outlets to connect equipment within cabinet.
- b. Power strips shall have a cord with a plug and shall be connected to specific receptacles on dedicated circuits; (1) L6-30P, (1) L5-20P.
- c. There may be various power strip types and configurations used on this project. Refer to drawings and product list for additional requirements.

G. Telecommunications Grounding Busbar (TGB)

- 1. Each Communications Room shall be installed with a dedicated telecommunications ground bus bar (TGB) and bonded to the telecommunications bonding backbone (TBB).
- 2. Each Equipment Cabinet, Equipment Rack, Ladder Rack or Wire Basket Tray, Conduit Sleeves, and other metallic components etc. shall be individually bonded and grounded to TGB. Overhead Ladder Rack or Basket Tray may have a single grounding connection to the ground bus bar, but shall have grounding jumpers provided between each segment (as required) for tray that does not have connectors which are UL listed for grounding.

3. Refer to Section 27 05 26 – Telecommunications Grounding and Bonding for additional requirements.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.
- B. Equipment Cabinet and/or Rack Installation:
 1. Cabinets and racks shall be vertically and horizontally level.
 2. Provide a junction plate at top of equipment rack and required cable runway to attach rack to cable runway around the perimeter of the Communications room. Junction plate must be fastened to frame without using “J” hooks so that no equipment space is lost.
 3. The completed equipment rack will be affixed to the floor using drop-in anchors and 5/8-inch zinc-plated hex bolts, split and flat washers.
 4. All equipment and components noted in this section and drawings shall be provided and completely setup and installed. This includes but not limited to Cabinets and Racks, Cable Management and Ladder Rack, Communication Wall Fields and Patch Panels, and Communications Rack Mounted Power Protection and Power Strips.
 5. All equipment shall be generally installed per drawings and field coordinated with current conditions and other trades. The final locations shall be coordinated with Owner, Architect, and Engineer prior to installation. No additional cost submitted by contractor shall be incurred by Owner due to Contractor’s failure to comply with this requirement.
- C. Drip Pans:
 1. Drip Pans: Where possible to run mechanical piping elsewhere, do not run mechanical piping directly above technology work which is sensitive to moisture. If no other options exist and after confirmation review with Engineer and Owner, provide drip pans under mechanical piping, sufficient to protect technology work from dripping.
 2. Locate pan immediately below piping, and extend a minimum of 6” on each side of piping and lengthwise 18” beyond equipment being protected.
 3. Fabricate pans 2” deep of reinforced sheet metal with rolled edges and soldered or welded seams; 22 gauge galvanized steel. Provide ¾” copper drainage piping from pan to nearest floor drain or similar suitable point of discharge, and terminate pipe as an open-sight drainage connection.
 4. Coordinate work with MEP Contractor.
 5. Insulate bottom of pan and drainage pipe as directed by Engineer.

D. Labeling:

1. The final labeling scheme shall be coordinated with Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.
2. Refer to Specification Section 27 05 00 for additional requirements that shall be fulfilled as part of this specification section.

END OF SECTION 27 11 00

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an “end-to-end” solution is provided by one of the “pre-approved” manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish “benchmark” products from one or more of the “pre-approved manufacturers”. The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
 - a. APC
 - b. Chatsworth-CPI
 - c. CommScope
 - d. Hoffman
 - e. Middle Atlantic
 - f. Ortronics
 - g. Panduit

Table 1 - Equipment Cabinets, Racks, and Accessories			
Item	Part Name/Description	Manufacturer	Part Number
1	45U - 2-post Equipment Rack (6-inch Channel)	Tripp Lite	SR2POST
		Chatsworth-CPI	66353-703
		CommScope	RK6-45A
2	Horizontal Power Distribution Unit (PDU) (L5-20P)	Tripp Lite	PDUMV20NETLX
3	Horizontal Power Distribution Unit (PDU) (L6-30P)	Tripp Lite	PDUMH30HVNET
4	Horizontal Cable Management	Panduit	WMPF1E

Table 2 - Raceway and Accessories			
Item	Part Name/Description	Manufacturer	Part Number
1	12-inch Ladder Rack Type Cable Tray (Black Powder Coat Finish)	Chatsworth-CPI	11252-712
		CommScope	CR-SLR-10L12W
		Legrand / Ortronics	TRT10-12B
2	Ladder Rack Triangular Support Bracket Aluminum 18-inch Wide (Black)	Chatsworth-CPI	11312-718
		CommScope	CRTWSBK-18W
		Legrand / Ortronics	P139540HB
3	Ladder Rack Suspended Mount Support Bracket Aluminum 12-inch Wide (Black)	Chatsworth-CPI	12362-712
		CommScope	CRCMK5-8TR
		Legrand / Ortronics	RCBK-6
4	Ladder Rack to Equipment Rack Support Brackets - Elevation Kit (Black)	Chatsworth-CPI	10595-712
		CommScope	CRR2RRMK
		Legrand / Ortronics	REK-4-6
5	12-inch Ladder Rack Radius Drop Out (Cross Member - Black)	Chatsworth-CPI	14304-702
		CommScope	CRDK-12W
		Legrand / Ortronics	TRP11-CM
6	12-inch Ladder Rack Radius Drop Out (Stringer Member - Black)	Chatsworth-CPI	14305-700
		CommScope	CRSMCRDK
		Legrand / Ortronics	TRP8-S
7	Ladder Rack Butt-Splice Kit (Black)	Chatsworth-CPI	11301-701
		CommScope	CRBSK
		Legrand / Ortronics	P820127H

Table 2 - Raceway and Accessories			
Item	Part Name/Description	Manufacturer	Part Number
8	Ladder Rack Junction Splice Kit (Black)	Chatsworth-CPI	11302-701
		CommScope	CRTJSK
		Legrand / Ortronics	P820147H
9	Equipment Grounding Components	Chatsworth-CPI	40164-001
		CommScope	CRGND
		Legrand / Ortronics	GS-8

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	EXPLANATION
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 27 13 13 - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Product Appendix: Refer to Appendix 1, Equipment Schedules, for specific product information on the benchmark products. These equipment schedules should be the baseline for product data submittals, but are not intended to be an all-encompassing bill of materials.
- B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.
- C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.
- D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.
- E. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.
- F. Rough carpentry is specified in a Division 6 section.

PART 2 - SYSTEM REQUIREMENTS

2.1 COMMUNICATIONS COPPER CABLING SYSTEM

- A. Topology:
 - 1. The Communications Copper Backbone Cabling will be an industry standard physical star topology with high pair count copper cabling interconnecting each Intermediate Cross-connect (IC) to the Copper Main Cross-Connect (MC) location, unless noted otherwise.
 - 2. For conditions where backbone cable is provided to non-communication room locations, all cabling topology shall follow the same requirements and originate from the MC unless noted otherwise.
 - 3. All cable splices shall be coordinated with Owner, Architect, and Engineer. This includes those shown on drawings and/or proposed by Contractor.
 - 4. Cable splices are only acceptable as noted on the drawings and must be approved by Owner, Architect, and Engineer.
 - 5. Cable splices are only intended where differing cable types are joined and/or multiple smaller cables are joined to a larger backbone feeder cables.
 - 6. Splices are not acceptable to extend cables of inadequate length.
 - 7. Refer to drawings for additional requirements.

B. General Requirements

1. All cable and terminations shall meet the minimum Performance and Criteria listed in specification below and on drawings, in accordance with TIA-568-C.2.
2. Cable requirements including cable types, quantities and pair / strand counts are specified on the drawings.
3. All cables shall have the appropriate fire spread rating per building codes, industry standard, and Underwriters Laboratory (UL/cUL) including plenum (CMP/OFNP/OFCP), riser (CMR/OFNR/OFRCR), etc. The contractor shall verify the appropriate cable is being used for application it is installed.
4. Any cable routed below grade shall utilize specific water block construction. Copper cables generally use gel-filled compound to achieve this rating. The contractor is required to submit a solution wherever this condition exists regardless of whether noted on drawings.
5. Underground rated cable that doesn't carry a suitable indoor building cable rating per building code and UL, shall not be routed more than 50-ft (15m) inside the building. Cable shall be spliced or terminated as appropriate and noted on drawings.
6. All armored and/or metallic cable sheaths shall be bonded to Telecommunications Ground Bus (TGB).

C. Performance and Criteria

1. General Copper Backbone Cabling Requirements: (as applicable per drawings)
 - a. Cable Rating:
 - 1) Riser Rated
 - b. Cable Construction:
 - 1) Construction: Unshielded Twisted Pair
 - 2) Medium: Solid Annealed Copper
 - c. Length Limitations: 2600-feet (800m) for telecommunications
 - d. Physical Specification:
 - 1) Standard Cable Sizes: 25, etc. per one-line drawings.
 - 2) Conductor Size: 24 AWG
 - e. Compliances: Refer to respective cables types in section 2.2.
 - f. Electrical Specifications:
 - 1) Characteristic Impedance: 100 Ohms
 - 2) Cat.3 Frequency: 1-16 MHz

g. Temperature:

- 1) CMP Operating and storage: -4 to +140F (-10 to +60C)
- 2) OSP Operating and storage: -40 to 158F (-40 to +70C)

h. Pulling Tensions (max): 25-lb (11 kg).

i. Transmission Performance (min.)

- 1) Refer to tables below for each applicable cable type.

2. Category 3 Telecommunications

a. Transmission Performance (min.)

1) Permanent Link

CATEGORY 3 - PERMANENT LINK		
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)
1.0	3.5	40.1
4.0	6.2	30.7
8.0	8.9	25.9
10.0	9.9	24.3
16.0	13.0	21.0

2) Channel

CATEGORY 3 - CHANNEL		
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)
1.0	4.2	39.1
4.0	7.3	29.3
8.0	10.2	24.3
10.0	11.5	22.7
16.0	14.9	19.3

3) Connecting Hardware

CATEGORY 3 - CONNECTING HARDWARE		
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)
1.0	3.5	40.1
4.0	6.2	30.7
8.0	8.9	25.9
10.0	9.9	24.3
16.0	13.0	21.0

- 4) Assembled Patch Cord
- a) Use Category 5E requirements if patch cords are used rather than cross-connect jumpers.

CATEGORY 5E – ASSEMBLED PATCH CORD				
Frequency (M Hz)	2 m Cord NEXT (dB)	5 m Cord NEXT (dB)	10 m Cord NEXT (dB)	Return Loss (dB)
1.0	65.0	65.0	65.0	19.8
4.0	62.3	61.5	60.4	21.6
8.0	56.4	55.6	54.7	22.5
10.0	54.5	53.7	52.8	22.8
16.0	50.4	49.8	48.9	23.4
20.0	48.6	47.9	47.1	23.7
25.0	46.7	46.0	45.3	24.0
31.25	44.8	44.2	43.6	23.0
62.5	39.0	38.5	38.1	20.0
100.0	35.1	34.8	34.6	18.0
Attenuation: per 100 meters (328-feet) @20 C=Horizontal UTP Cable Attenuation + 20%(due to Standard Conducts)				

2.2 CABLE REQUIREMENTS

A. General

1. The cables shall meet the minimum requirements noted in Performance and Criteria Section for each respective cable type based on TIA-568-C.2 equivalent cable rating.
2. Refer to Technology Drawings for all cable types, quantities and pair / strand counts.

B. Cat. 3 Riser Rated – Telecommunications Cables

1. Application: Building backbone and riser installation within duct, conduits or cable trays telecommunications backbone cable.
2. Construction:
 - a. Insulation: Flame retardant semi-rigid PVC.
 - b. Shield/Sheath: None.
 - c. Filling Compound: None.
 - d. Jacket: Flame retardant PVC.
3. Color: Gray.
4. Compliances: TIA-568-C.2, NEC/CEC Type CMR.

C. Cat. 3 Plenum Rated – Telecommunications Cables

2.3 TERMINATION REQUIREMENTS

A. General

1. Wiring terminals shall meet the minimum requirements noted in Performance and Criteria Section for each respective cable type, based on TIA-568-C.2 equivalent cable ratings.
2. Provide all necessary wiring terminals, jumper troughs, protector panel, ground wire and bonding to building ground, and plug in protectors (as applicable).
3. Temperature rating (unless noted otherwise):
 - a. Operating: +14 to +140 °F (-10 to +60 °C).
 - b. Storage: -40 to +158 °F (-40 to +70 °C).

B. Protector Panel and Building Entrance Terminal

1. General:
 - a. All copper service entrance pairs serving the building shall be terminated on a Protector Panel and Building Entrance Terminal.
 - b. All copper cable pairs routed to the exterior or routed to locations outside of building footprint shall be terminated on a Protector Panel at each end.
2. Type: 195-Type.
3. Mounting Configuration: Wall Mounted.
4. Protection: Ground Fault and Sneak Current.
5. Size: 100-Pair (and as required).
6. Cable Interface:
 - a. Input: 110-Type Wiring Block or RJ21X Connector.
 - b. Output: 110-Type Wiring Block or RJ21X Connector.
7. Protectors: Gas Discharge Tube (or Solid State) 5-Pin Plug In Protector (PIP).
8. Electrical Specifications:
 - a. TIA: Category 3
 - b. UL and cUL Listed
 - c. FCC Part 68

C. 110-Type Wiring Blocks

1. Type: 110-Type w/ Legs.
2. Mounting Configuration: Wall Mounted (or 19-inch Rack).
3. Size: 100-Pair or 300-Pair (and provided as required to terminate all cable).

4. Cable Interface:

- a. Input: 110-Type Wiring Block.
- b. Output: 110-Type Wiring Block.
 - 1) 5-Pin Connector for feeder cables greater than 4-pairs.
 - 2) 4-Pin Connector for 4-pair cables.

5. Electrical Specifications:

- a. TIA: Category 5E
- b. Insulation Resistance: 500 MegaOhms (minimum).
- c. Current Rating: 1.5A @68 °F (20 °C).
- d. Dielectric Withstand Voltage: 1000 VAC RMS, 60Hz (minimum), contact-to-contact and 1,500 VAC RMS, 60Hz (minimum) to exposed conductive surface.
- e. UL and cUL Listed
- f. FCC Part 68

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.
- B. Labeling:
 - 1. The final labeling scheme shall be coordinated with Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.
 - 2. Each cable, wiring block, patch panel, and termination shall be identified at the Main Cross-connect (MC), at the Intermediate Cross-connect (IC), and at each station termination.
 - 3. Refer to Specification Section 27 05 00 for additional requirements that shall be fulfilled as part of this specification section.
- C. Telecommunications Testing:
 - 1. All communications copper backbone cabling and pairs shall be tested for electrical continuity and wire map.
 - 2. All cabling will be test/certified for conformance to the TIA-568-C.2 Category 3 and Category 5 specifications (as applicable) using Level 2 test equipment in accordance with TIA-568-C.2.

3. Cable tests will be per industry standard and also include the following:
 - a. Cable Length
 - b. Attenuation
 - c. NEXT
 - d. Characteristic Impedance
 - e. Mutual Capacitance
 - f. Resistance
 - g. Noise
 - h. Wire Map
4. Electronic test results shall be submitted by the Contractor for approval by Owner, Architect, and Engineer.

END OF SECTION 27 13 13

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an “end-to-end” solution is provided by one of the “pre-approved” manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish “benchmark” products from one or more of the “pre-approved manufacturers”. The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
 - a. Circa
 - b. CommScope (Systimax)
 - c. General / Panduit
 - d. Superior Essex / Ortronics

Table 1 - Copper Backbone Cable / Connectivity Products			
Item	Part Name/Description	Manufacturer	Part Number
1	25-pair Category 3 - Riser Rated Cable	CommScope	1010A WH 25/24
		Superior Essex	18-025
		General Cable	2131505
2	50-pair Category 3 – M-Type 66-clip connecting block	Leviton	40066-M50
		Siemon	M4-12
		Ortronics	805003202

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	EXPLANATION
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Product Appendix: Refer to Appendix 1, Equipment Schedules, for specific product information on the benchmark products. These equipment schedules should be the baseline for product data submittals, but are not intended to be an all-encompassing bill of materials.
- B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.
- C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.
- D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.
- E. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.
- F. Rough carpentry is specified in a Division 6 section.

PART 2 - SYSTEM REQUIREMENTS

2.1 COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING SYSTEM

- A. Topology:
 - 1. The Optical Fiber Backbone Cabling will be an industry standard physical star topology with fiber optic cabling interconnecting each Intermediate Cross-connect (IC) to the Fiber Optic Main Cross-Connect (MC) location, unless noted otherwise.
 - 2. For conditions where backbone cable is provided to non-communication room locations such as Remote Hub locations, all cabling topology shall follow the same requirements and originate from the MC unless noted otherwise.
 - 3. All cable splices shall be coordinated with Owner, Architect, and Engineer. This includes those shown on drawings and/or proposed by Contractor.
 - 4. Cable splices are only acceptable as noted on the drawings and must be approved by Owner, Architect, and Engineer.
 - 5. Cable splices are only intended where differing cable types are joined and/or multiple smaller cables are joined to a larger backbone feeder cables.
 - 6. Splices are not acceptable to extend cables of inadequate cable lengths.
 - 7. Refer to drawings for additional requirements.

B. General Requirements:

1. All cable and terminations shall meet the minimum Performance and Criteria listed in specification below and on drawings, in accordance with TIA-568-C.3.
2. Cable requirements including cable types, quantities and pair / strand counts are specified on the drawings.
3. All cables shall have the appropriate fire spread rating per building codes, industry standard, and Underwriters Laboratory (UL/cUL) including plenum (CMP/OFNP/OFCP), riser (CMR/OFNR/OFRCR), etc. The contractor shall verify the appropriate cable is being used for application it is installed.
4. Any cable routed below grade shall utilize specific water block construction. Fiber optic cables can use dry water block tape or gel-filled compound to achieve this rating. The contractor is required to submit a solution wherever this condition exists regardless of whether noted on drawings.
5. Underground rated cable that doesn't carry a suitable indoor building cable rating per building code and UL, shall not be routed more than 50-ft (15m) inside the building. Cable shall be spliced or terminated as appropriate and noted on drawings.
6. Approved splices shall be low attenuation fusion type.
7. All armored and/or metallic cable sheaths shall be bonded to Telecommunications Ground Bus (TGB).
8. Fiber terminations shall swap transmit/receive polarity on far end of cable per industry standards for all mated or duplex connectors. This requirement shall be coordinated with Owner and Facility Operator.
9. Service loops shall be provided at each end of cable at the termination point.
10. Provide breakout or fan-out kits for all loose type fiber optic cables for transitioning to tight buffered cable at termination points.

C. Performance and Criteria:

1. General Fiber Backbone Cabling Requirements: (as applicable per drawings)
 - a. Cable Rating:
 - 1) Outside Plant / Underground w/ Water Block
 - 2) Riser Rated
 - 3) Plenum Rated
 - 4) Indoor / Outdoor
 - b. Cable Construction:
 - 1) Construction: Interlocking Armored and/or Non-Armored
 - c. Length Limitations: Refer to tables below.
 - d. Physical Specification:
 - 1) Strand Counts: 24, 48 and 96.
 - 2) Multi-mode Core Diameter: 50-Micron

- 3) Single-mode Core Diameter: 8-Micron
- 4) Cladding Diameter: 125-Micron

- e. Compliances: Refer to respective cables types in section 2.2.
- f. Temperature:

- 1) CMP Operating and storage: -4 to +140F (-10 to +60C)
- 2) OSP Operating and storage: -40 to 158F (-40 to +70C)

- g. Bend Radius (Minimum):

- 1) Installation: 20X Outside Cable Diameter.
- 2) Operating: 10X Outside Cable Diameter.

- h. Pulling Tensions (max): 25-lb (11 kg).

- i. Transmission Performance (min.)

- 1) Refer to tables below for each applicable cable type.

2. 50.0 – Micron Multi-Mode 300 (OM3)

- a. Transmission Performance:

50.0 - MICRON MULTI-MODE (OM3)						
Wavelength	Maximum	Bandwidth	Supported Ethernet Length			
	Attenuation	(MHz-km)	10 Mbps	100 Mbps	1 Gbps	10Gbps
850 nm	3.5 dB/km	2000 MHz-km	980-feet (300m)	980-feet (300m)	3280-feet (1000m)	980-feet (300m)
1300 nm	1.5 dB/km	500 MHz-km	6560-feet (2000m)	6560-feet (2000m)	1960-feet (600m)	980-feet (300m)

3. 50.0 – Micron Multi-Mode 550 (OM4)

- a. Transmission Performance:

50.0 - MICRON MULTI-MODE (OM4)						
Wavelength	Maximum	Bandwidth	Supported Ethernet Length			
	Attenuation	(MHz-km)	10 Mbps	100 Mbps	1 Gbps	10Gbps
850 nm	3.5 dB/km	4700 MHz-km	980-feet (300m)	980-feet (300m)	3600-feet (1100m)	1800-feet (550m)
1300 nm	1.5 dB/km	500 MHz-km	6560-feet (2000m)	6560-feet (2000m)	1960-feet (600m)	980-feet (300m)

4. 8.3 – Micron Single-Mode (SM2/OS2)

- a. Transmission Performance:

8.3 - MICRON SINGLE-MODE, (OS2)						
Wavelength	Maximum	Bandwidth	Supported Ethernet Length			
	Attenuation	(MHz-km)	10 Mbps	100 Mbps	1 Gbps	10Gbps
1310 nm	0.5 dB/km	100 TeraHz-km	9800-feet (3000m)	9800-feet (3000m)	9800-feet (3000m)	9800-feet (3000m)
1550 nm	0.5 dB/km	100 TeraHz-km	9800-feet (3000m)	9800-feet (3000m)	9800-feet (3000m)	9800-feet (3000m)

2.2 CABLING

A. General

1. This cable shall meet the minimum requirements noted in Performance and Criteria Section for each respective cable type based on ANSI/TIA/EIA-568-C.3 equivalent cable rating.
2. Refer to Technology Drawings for all cable types, quantities and pair / strand counts.

B. Interlocking Armored Building Cables

1. Riser Rated (CMR / OFCR)
 - a. Application:
 - 1) Building Cable is intended for interior building backbone and riser distribution installation within duct, conduits, and/or cable tray.
 - b. Construction:
 - 1) Jacket: Flame Retardant, Riser Rated, (CMR / OFNR)
 - 2) Fiber Buffer: Tight Buffered, 900-micron.
 - 3) Armor: Interlocking Aluminum.
 - 4) Strength Member: Aramid Strength Yarn.
 - 5) Water Block/Filling Compound: None.
 - c. Compliances:
 - 1) ANSI/TIA/EIA-568-C.3
 - 2) NEC/CEC Type CMR / OFCR.

C. Non-Armored Building Cables

1. Plenum Rated (CMP / OFNP)
 - a. Application:
 - 1) Building Cable is intended for interior building backbone and riser distribution installation within duct, conduits, and/or cable tray. Requires installation within inner-duct to protect cable.
 - b. Construction:
 - 1) Jacket: Flame Retardant, Plenum Rated, (CMP / OFNP)
 - 2) Fiber Buffer: Tight Buffered, 900-micron.
 - 3) Armor: None.

- 4) Strength Member: Aramid Strength Yarn.
- 5) Water Block/Filling Compound: None.

c. Compliances:

- 1) ANSI/TIA/EIA-568-C.3
- 2) NEC/CEC Type CMP / OFNP.

D. Indoor/Outdoor Interlocking Armored Building Cables

1. Riser Rated (CMR / OFCR)

a. Application:

- 1) Indoor/Outdoor Building Cable is intended for interior, exterior and outdoor building backbone and riser distribution installation within duct, conduits, and/or cable tray.

b. Construction:

- 1) Jacket: Flame Retardant, Riser Rated, (CMR / OFNR)
- 2) Fiber Buffer: Tight Buffered, 900-micron.
- 3) Armor: Interlocking Aluminum.
- 4) Strength Member: Aramid Strength Yarn.
- 5) Water Block/Filling Compound: Yes, Water Block Construction.

c. Compliances:

- 1) ANSI/TIA/EIA-568-C.3
- 2) NEC/CEC Type CMR / OFCR.

E. Outside Plant (OSP) Cables

1. Loose Tube Interlocking Armored OSP Cables

a. Application:

- 1) Underground duct
- 2) Trunk, distribution and feeder cable
- 3) Local loop, metro, long-haul and broadband network

b. Construction:

- 1) Jacket: UV resistant
- 2) Fiber Buffer: Loose Buffered
- 3) Armor: Corrugated steel interlocking

- 4) Strength Member: Central and dielectric water-blocking
- 5) Water Block/Filling Compound: Gel (PFM or generic)

c. Compliances:

- 1) Telcordia GR-20-CORE
- 2) RDUP PE-90 Designation MLT
- 3) ICEA S-87-640-2006
- 4) RoHS-compliant

2.3 TERMINATION EQUIPMENT

A. General

- 1. Fiber terminations shall meet the minimum requirements noted in Performance and Criteria Section for each respective cable type, based on ANSI/TIA/EIA-568-C.3 equivalent cable ratings.
- 2. Provide all necessary fiber enclosures, splice trays, and connectors (as applicable). Refer to Technology Drawings for additional information.

B. Termination Type Requirements

- 1. Pre-terminated fiber module with pigtail for fusion splicing, mounted within splice tray.

C. Connectors

1. General:

- a. Ferrule: Ceramic
- b. Fiber Buffer Size: 900-micron
- c. Optical Specification:
 - 1) Multi-mode
 - 2) Single-mode
 - 3) Insertion Loss (Typical / Max.): <0.3dB / <0.75dB
- d. Plug Requirements:
 - 1) Retention Force (Buffer): 2-lb (0.9kg)
 - 2) Retention Force (Cordage): 10-lb (4.5kg)
 - 3) Insertion Life: 500 minimum.
- e. Temperature rating (operating): -40 to +167 °F (-40 to +75 °C).

2. LC-Type

- a. Application / Fiber Type:
 - 1) Multi-mode
 - 2) Single-mode
- b. Form Factor: Small Form Factor (SFF)
- c. Adapter Type: Duplex
- d. Form Factor: Small Form Factor (SFF)

3. SC-Type

- a. Application / Fiber Type:
 - 1) Single-mode
- b. Adapter Type: Duplex
- c. Form Factor: Small Form Factor (SFF)
- d. Polish: Angled Polished Connectors (APC)

D. Enclosures

1. General:

- a. Use: Enclosure or housing for consolidating connectors and/or splicing of high density optical fiber typically at communication distribution and equipment rooms.
- b. Mounting Configuration: FACT Frame
- c. Cable Managers:
 - 1) Internal strand managers for service loops and strand management in back side.
 - 2) Internal patch cord manager at front side.
 - 3) Cable access on both sides at front and back sides. Access points should have integrated curved guards to support appropriate cable bends.

2. Element – Rack Mount Fiber Optic Housing

- a. Application: Fiber Optic Rack mount fiber terminations.
- b. Size: Element size 1E, 2E, 3E, 6E

E. Splice Trays

1. General:
 - a. Shall meet the minimum requirements noted in Performance and Criteria Section.
 - b. Dedicated splice trays may not be necessary as enclosures with built in splice trays may be acceptable, if submitted and accepted by Owner / Engineer.
2. Application:
 - a. Provide protection and slack management of heat shrink fusion spliced fibers.
 - b. Splice tray to be used with enclosures noted below.
3. Fiber Types supported:
 - a. Micron Multi-Mode (OM3, OM4)
 - b. Micron Single-Mode (OS1, SM2)
4. Related components to be provided (as necessary):
 - a. Mounting hardware kits
 - b. Heat shrink splice sleeve (40mm and/or 60mm lengths)

2.4 PATCH CORDS

- A. General Requirements:
1. The patch cords shall meet the minimum requirements noted in Performance and Criteria Section for each respective cable type based on ANSI/TIA/EIA-568-C.3 equivalent cable rating.
 2. Patch cords shall be provided as part of project at main cross-connects, intermediate cross-connects, and horizontal cross-connects (as applicable).
 3. All fiber optic patch cords shall be from the same manufacturer as the fiber optic backbone and shall meet all performance requirements established in earlier sections of this specification.
 4. Lengths and Colors: Refer to Technology Drawings (symbol legend) for additional requirements on various patch cord lengths and/or colors.
 5. When provided by Contractor, patch cords to be provided for all fiber and connector types included in project, per sections 2.1, 2.2, and 2.3 of this specification section.
 6. Refer to Technology Drawings (symbol legend) for additional requirements on various patch cord types, lengths and/or colors.

2.5 MISCELLANEOUS COMPONENTS

A. Grounding Components:

1. All fiber optic cabling with metallic sheath (i.e. Interlocking Armored Fiber) shall be grounded at each end, if cable exits the room.
2. Provide armored fiber jacket grounding straps grounded to telecom grounding busbar or ladder rack (not equipment rack), per manufacturer recommendations.

2.6 PATHWAYS

A. Inner-Duct:

1. Provide appropriately rated fiber optic inner-duct for incoming service conduits and any locations where non-armored fiber optic cable is installed. Refer to Technology Drawings for additional information, but inner-duct rating types used on this project may include:
 - a. Outside Plant
 - b. Interior Riser Rated

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

B. Grounding:

1. All fiber optic cabling with metallic sheath (i.e. Interlocking Armored Fiber) shall be grounded at each end per manufacturer recommendations, if cable exits the room.
2. Refer to Telecommunications Grounding and Bonding specification section 27 05 26 for additional requirements.

C. Labeling:

1. The final labeling scheme shall be coordinated with Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.
2. Each cable, termination panel, and termination shall be identified at the Main Cross-connect (MC), at the Intermediate Cross-connect (IC), and at each station termination.
3. Refer to Specification Section 27 05 00 for additional requirements that shall be fulfilled as part of this specification section.

D. Fiber Optic Testing/Certification (Passive)-EIA/TIA-526-14

1. Multi-mode Fiber:

- a. All fiber optics will be tested for end-to-end attenuation at 850nm and 1300nm; using an optical power source and an optical power meter.
- b. Tests will be performed after connectors have been installed, and will be from jumper side of hub(s) bulkhead connector to the jumper side of the bulkhead connectors at the MC/IC fiber interconnect panel.
- c. Maximum loss will not exceed manufacturers' passive cable system attenuation; adjusted for cable length connector loss.
- d. Maximum connector pair loss is .5dB. Splices are not acceptable in this system.
- e. Test results, including OTDR printouts, will be included in the final documentation package.
- f. Contractor shall complete a fiber optic post installation report at the time of testing containing meter readings at both 850 nm and 1300 nm from both directions on each fiber. Report shall include actual loss and other pertinent data regarding the cables tested, including model and serial number of test equipment, cable part number, installed fiber length, building span loss at 850 nm and 1300 nm and date tested.
- g. Span loss calculations are required on the final test sheet for loss at 850 nm and 1300 nm for multimode.

$$(D \times L) + (C \times \# \text{ connectors})$$

D = Length; L = Loss; C = Connector loss (Max 0.75 dB)

1 ft. = 0.0003048 km.

2. Single-mode Fiber:

- a. All fiber Optics will be tested for end-to-end attenuation at both 1310nm and 1550nm; using an optical power source and an optical power meter.
- b. Tests will be performed after connectors have been installed, and will be from jumper side of the hub(s) bulkhead connector to the jumper side of the bulkhead connectors at the MC/IC fiber interconnect panel.
- c. Maximum loss will not exceed manufacturer's passive cable system attenuation; adjusted for cable length and connector loss.
- d. Maximum connector pair loss is 0.5 dB. Splices are not acceptable in this system.
- e. Test results including OTDR printouts will be included in the final documentation package.
- f. Contractor shall complete a fiber optic post installation report at the time of testing containing meter readings at both 1310nm and 1550nm from both directions on each fiber. Report shall include actual loss and other pertinent data regarding the cables tested, including model and serial number of test equipment, cable part number, installed fiber length, building span loss at 1310nm and 1550nm and date tested.

- g. Span loss calculations are required on the final test sheet for loss at 1310nm and 1550nm for single-mode.

$$(D \times L) + (C \times \# \text{ connectors})$$

D = Length; L = Loss; C = Connector loss (Max 0.75 dB)

1 ft. = 0.0003048 km.

END OF SECTION 27 13 23

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an “end-to-end” solution is provided by one of the “pre-approved” manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish “benchmark” products from one or more of the “pre-approved manufacturers”. The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
 - a. CommScope (Systimax)
 - b. Belden
 - c. Superior Essex / Ortronics

Table 1 - Fiber Optic Cables			
Item	Part Name/Description	Manufacturer	Part Number
1	OS2 (G657.A1) Single-mode (OFNP) Plenum Rated Premises Cable (Non-Armored)	CommScope	P-XXX-DS-8W-FSUYL
		Superior Essex	44XXXXK
		Superior Essex	44XXXXK1
		Belden	FISDxxxP9
2	OS2 (G657.A1) Single-mode (OFCR) Riser Rated Premises Cable (Armored)	CommScope	R-XXX-DZ-8W-FSUYL
		Superior Essex	L3XXXXK
		Belden	FISDxxxP9
3	OS2 (G657.A1) Single-mode (OSP) Outside Plant Loose Tube Cable (Armored)	CommScope	D-XXX-LA-8W-F12NS
		Superior Essex	12xxxKD01
		Belden	FSSLxxx6D
4	12A Grounding Clamp (for Armored Fiber)	CommScope	GAK-FEC001
		Legrand / Ortronics	Submit for Approval

Table 2 - Fiber Optic Connectivity Products			
Item	Part Name/Description	Manufacturer	Part Number
1	High Density 1U modular cassette sliding Panel, accepts (4) G2 modules or MPO panels, providing up to 48 duplex LC ports, or up to 32 MPO ports	CommScope	760209940 HD-1U

Table 2 - Fiber Optic Connectivity Products			
Item	Part Name/Description	Manufacturer	Part Number
2	G2 ULL Singlemode MPO-12 Distribution Module, 24LC to 2X12f MPOs unpinned, internal shutters	CommScope	760238083 DM12-24LC-SM-ULL
3	OS2 Single-mode Splice Cassette (LC-type) Pre-terminated with pigtails	CommScope	G2-SP-12LCG-PT

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	EXPLANATION
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Product Appendix: Refer to Appendix 1, Equipment Schedules, for specific product information on the benchmark products. These equipment schedules should be the baseline for product data submittals, but are not intended to be an all-encompassing bill of materials.
- B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.
- C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.
- D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.
- E. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.
- F. Rough carpentry is specified in a Division 6 section.

PART 2 - SYSTEM REQUIREMENTS

2.1 HORIZONTAL STRUCTURED CABLING SYSTEM

- A. Topology
 - 1. The Communications Horizontal Cabling will be an industry standard physical star topology with cabling routed to each communication device outlet location from the nearest Horizontal Cross-connect (HC) location, unless noted otherwise.
 - 2. Communications horizontal cabling shall not exceed a total cable length of 295-feet (90m) for the permanent basic link. The channel length shall not exceed 325-feet (100m) when patch cords are installed.
 - 3. Contractor(s) responsible for providing the communications horizontal raceway and/or cabling shall ensure that the pathway and cable to each device location does not exceed 295-feet (90m) length back to the nearest HC location. Contractor shall bring any distance concerns to the attention of the Architect and Engineer during the bid process and/or at a minimum during the shop drawing process, prior to installation.
 - 4. Contractor shall immediately notify Owner, Architect, and Engineer of any cable segment that exceeds the length limitation.
 - 5. Refer to drawings for additional requirements.

B. General Requirements

1. All cable and terminations shall meet the minimum Performance and Criteria listed in specification below and on drawings.
2. Cable requirements including cable quantities are specified on the drawings.
3. All cables shall have the appropriate fire spread rating per building codes, industry standard, and Underwriters Laboratory (UL/cUL) including plenum (CMP/OFNP/OFCP), riser (CMR/OFNR/OFRCR), etc. The contractor shall verify the appropriate cable is being used for application it is installed.
4. Any cable routed outside and/or below grade shall utilize specific water block construction. Cables generally use gel-filled compound to achieve this rating for copper cable and dry water block paper for others. The contractor is required to submit an Outdoor Rated and/or Underground Rated solution wherever this condition exists regardless of whether noted on drawings.
5. Outdoor Rated and/or Underground Rated cable that doesn't carry a suitable building cable rating per building code and UL, shall not be routed more than 50-ft (15m) inside the building. Cable shall be spliced or terminated as appropriate and noted on drawings.
6. Cabling system shall be procured from a single manufacturer that offers a complete end-to-end certified and warranted system for the TIA-568-C.2 Category noted for each system. Additionally, all products provided shall be the newest products offered by the manufacturer for the product category specified.
7. Cable splices of any kind are not acceptable for communications horizontal cabling system.
8. Cables from different low voltage systems (ex. 70v Speaker, BMS, etc.) shall not be run in the same conduit pathways unless specifically noted on the drawings.

C. Performance and Criteria

1. General Horizontal Cabling Requirements:
 - a. Cable Rating:
 - 1) Plenum Rated (CMP).
 - 2) Riser Rated (CMR) or General Rated (CM) when installed in continuous conduits or non-plenum spaces as determined by Authority Having Jurisdiction (AHJ).
 - 3) Outdoor Rated (all outdoor or below grade applications).
 - b. Cable Construction:
 - 1) Type: Unshielded Twisted Pair.
 - 2) Medium: Solid Annealed Copper.
 - c. Length Limitations:
 - 1) 295-feet (90m).

d. Physical Specification

- 1) Standard Cable Sizes: 4-pairs.
- 2) Conductor Size: 24 AWG.

e. Compliances:

- 1) TIA-568-C.2,
- 2) NEC/CEC Type CMP.

f. Electrical Specification

- 1) Characteristic Impedance: 100 Ohms.
- 2) Cat.6 Frequency: 1-250 MHz.

g. Temperature:

- 1) CMP Operating and storage: -4 to +140F (-10 to +60C)
- 2) OSP Operating and storage: -40 to 140F (-40 to +60C)

h. Pulling Tensions (max): 25-lb (11 kg).

i. Transmission Performance (min.)

- 1) Refer to tables below for each applicable cable type.

2. Category 6

a. Transmission Performance (min.)

1) Permanent Link

CATEGORY 6 – PERMANENT LINK						
Frequency (M Hz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ELFEX T (dB)	PSELFEX T (dB)	Return Loss (dB)
1.0	1.9	65.0	62.0	64.2	61.2	19.1
4.0	3.5	64.1	61.8	52.1	49.1	21.0
8.0	5.0	59.4	57.0	46.1	43.1	21.0
10.0	5.5	57.8	55.5	44.2	41.2	21.0
16.0	7.0	54.6	52.2	40.1	37.1	20.0
20.0	7.9	53.1	50.7	38.2	35.2	19.5
25.0	8.9	51.5	49.1	36.2	33.2	19.0
31.25	10.0	50.0	47.5	34.3	31.3	18.5
62.5	14.4	45.1	42.7	28.3	25.3	16.0
100.0	18.6	41.8	39.3	24.2	21.2	14.0

CATEGORY 6 – PERMANENT LINK						
Frequency (M Hz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ELFEX T (dB)	PSELFEX T (dB)	Return Loss (dB)
200.0	27.4	36.9	34.3	18.2	15.2	11.0
250.0	31.1	35.3	32.7	16.2	13.2	10.0
Minimum Link Propagation Delay: 498ns @10MHz						
Maximum Link Delay Skew: 44ns/100m @10MHz						

2) Channel

CATEGORY 6 – CHANNEL						
Frequency (M Hz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ELFEX T (dB)	PSELFEX T (dB)	Return Loss (dB)
1.0	2.1	65.0	62.0	63.3	60.3	19.0
4.0	4.0	63.0	60.5	51.2	48.2	19.0
8.0	5.7	58.2	55.6	45.2	42.2	19.0
10.0	6.3	56.6	54.0	43.3	40.3	19.0
16.0	8.0	53.2	50.6	39.2	36.2	18.0
20.0	9.0	51.6	49.0	37.2	34.2	17.5
25.0	10.1	50.0	47.3	35.3	32.3	17.0
31.25	11.4	48.4	45.7	33.4	30.4	16.5
62.5	16.5	43.4	40.6	27.3	24.3	14.0
100.0	21.3	39.9	37.1	23.3	20.3	12.0
200.0	31.5	34.8	31.9	17.2	14.2	9.0
250.0	35.9	33.1	30.2	15.3	12.3	8.0
Minimum Link Propagation Delay: 555ns @10MHz						
Maximum Link Delay Skew: 50ns/100m @10MHz						

3) Connecting Hardware

CATEGORY 6 – CONNECTING HARDWARE				
Frequency (M Hz)	Insertion Loss (dB)	NEXT (dB)	FEXT (dB)	Return Loss (dB)
1.0	0.10	75.0	75.0	30.0
4.0	0.10	75.0	71.1	30.0
8.0	0.10	75.0	65.0	30.0
10.0	0.10	74.0	63.1	30.0
16.0	0.10	69.9	59.0	30.0
25.0	0.10	66.0	55.1	30.0
31.25	0.11	64.1	53.2	30.0
62.5	0.16	58.1	47.2	28.1

CATEGORY 6 – CONNECTING HARDWARE				
Frequency (M Hz)	Insertion Loss (dB)	NEXT (dB)	FEXT (dB)	Return Loss (dB)
100.0	0.20	54.0	43.1	24.0
200.0	0.28	48.0	37.1	18.0
250.0	0.32	46.0	35.1	16.0

4) Assembled Patch Cord

CATEGORY 6 – ASSEMBLED PATCH CORD				
Frequency (M Hz)	2 m Cord NEXT (dB)	5 m Cord NEXT (dB)	10 m Cord NEXT (dB)	Return Loss (dB)
1.0	65.0	65.0	65.0	19.8
4.0	65.0	65.0	65.0	21.6
8.0	65.0	65.0	64.8	22.5
10.0	65.0	64.5	62.9	22.8
16.0	62.0	60.5	59.0	23.4
20.0	60.1	59.6	57.2	23.7
25.0	58.1	56.8	55.4	24.0
31.3	56.2	54.9	53.6	23.0
62.5	50.4	49.2	48.1	20.0
100.0	46.4	45.3	44.4	18.0
125.0	44.5	43.5	42.7	17.0
150.0	43.0	42.1	41.4	16.2
175.0	41.8	40.9	40.2	15.6
200.0	40.6	39.8	39.3	15.0
225.0	39.7	38.9	38.4	14.5
250.0	38.8	38.1	37.6	14.0

2.2 CABLE REQUIREMENTS

A. General

1. The cables shall meet the minimum requirements noted in Performance and Criteria Section for each respective cable type based on TIA -568-C.2 equivalent cable rating.
2. Colors:
 - a. Device outlets, patch panel termination labels, and patch cords may be colored to differentiate applications types. Horizontal voice/data cables do not require separate colors. Refer to Technology drawings (symbol legend) for additional requirements on color coding.

B. Category 6 Plenum Rated – Horizontal Cable

1. General:
 - a. This cable shall meet the minimum requirements noted in Performance and Criteria Section for Category 6.
2. Application: Primarily for communications horizontal cable installation within duct, conduits or cable trays. May also serve in the building backbone and riser applications.
3. Construction:
 - a. Insulation: Flame retardant semi-rigid Fluoropolymer.
 - b. Shield/Sheath: None.
 - c. Filling Compound: None.
 - d. Jacket: Flame retardant PVC.

C. Category 6 Outdoor Rated – Horizontal Cable

1. General:
 - a. This cable shall meet the minimum requirements noted in Performance and Criteria Section for Category 6.
2. Application: Primarily for communications horizontal cable installation within duct or conduits in outdoor or underground locations.
3. Construction:
 - a. Insulation: Polyethylene.
 - b. Shield/Sheath: None.
 - c. Filling Compound: Yes, water block filling compound.
 - d. Jacket: Polyethylene.

2.3 TERMINATION REQUIREMENTS

A. General

1. All terminations shall meet the minimum requirements noted in Performance and Criteria Section for each respective cable type based on TIA -568-C.2 equivalent cable rating.
2. All terminations for copper cables located on the face of the building or at remote locations outside of the building footprint (i.e., IP security cameras, WLAN data, etc.) shall have surge protectors at the termination point within the communications room. Contractor shall comply with manufacturer recommendations.
3. Specific and dedicated patch panels shall be used when multiple TIA-568-C.2 cable categories are used on the same project.
4. Provide all necessary wiring terminals and horizontal cable managers.

5. Provide double-sided horizontal cable manager above and below each patch panels as indicated in 271100.
6. Terminate 4-pairs per RJ45 jack per T568B standard termination. Exact requirements shall be coordinated and approved with Owner, Architect, and Engineer prior to initiating any work.
7. Specific communication device outlet types shall be grouped together on patch panels. Additionally, 20% spare jacks shall be added within each grouping.

B. RJ45-Type Patch Panels

1. Type: RJ45-Type.
2. Pin Configuration: T568B.
3. Mounting Configuration: 19-inch Rack.
4. Size: 48-port (provide as required to terminate all cable).
5. Colors:
 - a. Patch panel termination labels may require color coding to differentiate applications types. Refer to Technology drawings (symbol legend) for additional requirements on color coding.
6. Cable Interface:
 - a. Input: 110-Type (back).
 - b. Output: RJ45-Type (front).
7. Electrical Specifications:
 - a. TIA-568-C.2:
 - b. Insulation Resistance: 500 MegaOhms (minimum).
 - c. Current Rating: 1.5A @68 °F (20 °C).
 - d. Dielectric Withstand Voltage: 1000 VAC RMS, 60Hz (minimum), contact-to-contact and 1,500 VAC RMS, 60Hz (minimum) to exposed conductive surface.
 - e. UL and cUL Listed
 - f. FCC Part 68.
8. Plug Requirements:
 - a. Retention Force: 30-lb (133N).
 - b. Insertion Life: 750 minimum.
 - c. Plug/Jack Contact Force: 0.22-lb (100g).
9. Temperature
 - a. Operating: +14 to +140 °F (-10 to +60 °C).
 - b. Storage: -40 to +158 °F (-40 to +70 °C).

C. RJ45-Type Device Outlet Jacks

1. Type: RJ45-Type
2. Pin Configuration: T568B.
3. Mounting Configuration: Faceplates, Trim Plates, and Modular Patch Panels.
4. Colors:
 - a. Jacks and/or termination labels may require color coding to differentiate applications types. Refer to Technology drawings (symbol legend) for additional requirements on color coding.
5. Cable Interface:
 - a. Input: 110-Type (back).
 - b. Output: RJ45-Type (front).
6. Electrical Specifications:
 - a. TIA-568-C.2:
 - b. Insulation Resistance: 500 MegaOhms (minimum).
 - c. Current Rating: 1.5A @68 °F (20 °C).
 - d. Dielectric Withstand Voltage: 1000 VAC RMS, 60Hz (minimum), contact-to-contact and 1,500 VAC RMS, 60Hz (minimum) to exposed conductive surface.
 - e. UL and cUL Listed
 - f. FCC Part 68.
7. Plug Requirements:
 - a. Retention Force: 30-lb (133N).
 - b. Insertion Life: 750 minimum.
 - c. Plug/Jack Contact Force: 0.22-lb (100g).
8. Temperature
 - a. Operating: +14 to +140 °F (-10 to +60 °C).
 - b. Storage: -40 to +158 °F (-40 to +70 °C).

D. Faceplates:

1. General:
 - a. Faceplates and/or trim plates shall be provided at each communication device location as necessary to install jacks.
 - b. No communication device cable and outlet jack shall be installed without a faceplate to tightly secure assembly.

- c. All unused ports shall have a blank dust cover installed. The color of each dust cover shall match the faceplate color as closely as possible, unless otherwise indicated.
 - d. Faceplate and/or surface box shall be provided at modular furniture locations. Coordinate requirements with Owner, Architect, and Engineer prior to purchasing components and initiating installation.
 - e. Wall telephone locations shall use a modular faceplate with standard integrated mounting knobs for installing telephone handset to wall.
 - f. Coordinate faceplate requirements at specialty locations for floor boxes, surface raceway, surface mount boxes, and other locations accordingly.
- 2. Material: (Refer to Technology Drawing details for additional information.)
 - a. Wall Devices: Stainless Steel.
 - 3. Type: RJ45 Standard Form Factor.

2.4 PATCH CORD REQUIREMENTS

A. General:

- 1. The patch cords shall meet the minimum requirements noted in Performance and Criteria Section for Category 5E, 6, and 6A as applicable based on TIA-568-C.2 equivalent cable rating.
- 2. Patch cords shall be provided as part of project at main cross-connects, intermediate cross-connects, horizontal cross-connects, and communication device outlet locations.
- 3. Exact patch cords requirements including TIA-568-C.2 category, quantity, and lengths shall be coordinated with Owner, Architect, and Engineer.
- 4. The sum of patch cord lengths when added the permanent basic link shall not exceed 325-feet (100m).
- 5. Construction: Unshielded Twisted Pair type.
- 6. Electrical Specifications:
 - a. TIA-568-C.2:
 - b. UL and cUL Listed CM Cordage
 - c. FCC Part 68.
- 7. Plug Requirements:
 - a. Retention Force: 30-lb (133N).
 - b. Insertion Life: 750 minimum.
 - c. Plug/Jack Contact Force: 0.22-lb (100g).

8. Temperature
 - a. Operating: 14 to +140 °F (-10 to +60 °C).
 - b. Storage: -4 to +140 °F (-20 to +60 °C).
9. Lengths: Refer to Technology drawings (symbol legend) for additional requirements on various patch cord lengths.
10. Colors:
 - a. Patch cords shall be colored to differentiate applications types. Refer to Technology drawings (symbol legend) for additional requirements on color coding and quantities.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.
- B. Elevator Interface
 1. Provide for Elevator Junction Box requirements, as follows:
 - a. Low Voltage Cabling Contractor shall provide an elevator device junction box located within or outside of the Elevator Machine Room, for interface of elevator devices (elevator phones, IP security cameras, etc.) to be located within the elevator cab(s). This requirement complies with ANSI A17.1 code which prevents work within the Elevator Machine Room, other than specific elevator work.
 - b. Elevator device J-box shall include a keyed lockable door. Additionally, J-box shall have proper terminal strips suitable for terminating all cables within the J-box.
 - c. Coordinate exact location of elevator device junction box with the Elevator Contractor, Architect, and Engineer, prior to installation.
 - d. Provide all cabling as required between the elevator device J-box and the IC-room for all elevator device interfaces.
 - e. Provide all required interface points for connecting to elevator relays and travel cables.
 - f. The Elevator Contractor shall provide all cables in conduit from the elevator machine room to the associated elevator device J-box.
 - g. Cables entering the elevator device J-box shall be appropriately labeled by the Elevator Contractor, so that the Low Voltage Cabling Contractor can connect to the appropriate wires. Wires should be individually labeled to separate them from other elevator functions and to assist the Low Voltage Cabling Contractor in making proper connection points.

C. Labeling:

1. The labeling scheme shall be provided by the Contractor and coordinated with Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.
2. Each cable, wiring block, patch panel, and termination shall be identified at the main cross-connect (MC), at the intermediate cross-connect (IC), and at each station termination.
3. Refer to Specification Section 27 05 00 for additional requirements that shall be fulfilled as part of this specification section.

D. Horizontal Systems Cable Testing:

1. All communications copper horizontal cabling and pairs shall be tested for electrical continuity and wire map.
2. Cable testing shall confirm to the cables TIA-568-C.2 rating.
3. All cabling will be test/certified for conformance to the TIA-568-C.2 Category Category 5E, Category 6, and Category 6A specifications using TSB-67 Level 4 time domain reflectometer (TDR) or approved equivalent test equipment.
4. Cable tests will be per industry standard and also include the following:
 - a. Cable Length
 - b. Attenuation
 - c. NEXT
 - d. Characteristic Impedance
 - e. Mutual Capacitance
 - f. Resistance
 - g. Noise
 - h. Wire Map
5. (5) Printed test results shall be submitted on disc and printed copies by the Contractor for approval by Owner, Architect, and Engineer.

END OF SECTION 27 15 00

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an “end-to-end” solution is provided by one of the “pre-approved” manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish “benchmark” products from one or more of the “pre-approved manufacturers”. The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
 - a. CommScope (Systimax)
 - b. Corning
 - c. Berk-Tek / Leviton
 - d. Belden
 - e. General / Panduit
 - f. Superior Essex / Ortronics

Table 1 - Horizontal Cable / Connectivity Products			
Item	Part Name/Description	Manufacturer	Part Number
1	Category 6 Plenum Rated Cable	CommScope Systimax	2071E
		Superior Essex	77-###-yB
		Belden	2413
2	Category 6 OSP Rated Cable, Gel-filled	CommScope Systimax	1572A
		Superior Essex	04-001-68
		Belden	OSP6U
3	Category 6 Indoor/Outdoor Cable	CommScope	CS34P-IO
		Superior Essex	04-001-63
		Belden	2143A
4	Category 6 Information Outlet (XX = Color)	CommScope Systimax	MGS400-XX
		Leviton	61110-RX6
		Belden	AX101321

Table 1 - Horizontal Cable / Connectivity Products			
Item	Part Name/Description	Manufacturer	Part Number
5	24-port Patch Panel - Modular (Individual Jack Inserts)	CommScope Systimax	360-E-MOD-1U-24
		Leviton	49255-H24 - 1U
		Belden	AX103114
6	48-port Patch Panel - Modular (Individual Jack Inserts)	CommScope Systimax	360-E-MOD-2U-48
		Leviton	49255-H48 - 2U
		Belden	AX103115

Table 2 - Miscellaneous Connectivity Products			
Item	Part Name/Description	Manufacturer	Part Number
1	Surface Mount Box "Biscuit" (# = Number of Ports, XX = Color)	CommScope	M10#SMB-B-XX
		Leviton	41089-#XP
		Belden	AX105353
2	Blank Outlet Dust Covers (XX = Color)	CommScope	M20AP-XX
		Leviton	41084-0BX
		Belden	AX102262
3	Stainless Steel Faceplates (with label window) (# = Number of Ports)	CommScope	M1#SP-L
		Leviton	43080-1L#
		Belden	AX104231
4	Plastic Faceplates (with label window) (# = Number of Ports, XX = Color)	CommScope	M1#L-XX
		Leviton	42080-#XS
		Belden	AX102655

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	EXPLANATION
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 28 46 00 - ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of contract, including General and Supplementary conditions and Division 1 specification sections, apply to work of this section.
- B. Division 26, Basic Electrical Materials and Methods applies to work specified in this section.
- C. Division 26 "Electrical Identification" applies to work in this section for labeling of conduit and equipment.
- D. Related work specified in other divisions of these specifications.
 - 1. Installation of duct type smoke detectors. Control wiring from Fire Alarm Control equipment to mechanical fans, dampers, control equipment both low voltage and line voltage and all other control wiring associated with mechanical equipment.

1.2 SUMMARY

- A. Provide a complete and coordinated Class A wiring, fire alarm system in accordance with the contract documents. Audible intelligibility shall be provided throughout the building.
- B. Contractor to include any and all hardware expansions and firmware updates to the existing Fire alarm system to be included in all renovated space.
- C. Any fire alarm devices, wiring etc., not indicated on the drawings, but required by the local Building Department and Fire Department, shall be provided as part of this specification. Contractor shall adjust locations and quantities of fire alarm devices as required to comply with local codes. As minimum, an additional 5 audio/visual alarms, 5 smoke detectors, and 5 addressable interface devices shall be included for each building or interiors renovation project occurring at the base area for pricing, including labor.
- D. Refer to Life Safety Report for additional requirements and fire alarm matrix.
- E. Contractor shall assume all responsibilities for obtaining a fire alarm permit.
 - 1. Contractor / Fire Alarm Installer shall develop a submittal including plan drawings, calculations, etc. to submit to the local jurisdictional authority in order to obtain a permit.
 - 2. Contractor / Fire Alarm Installer shall provide and apply a seal / signature to fire alarm drawings as required by the authority having jurisdiction in order to obtain a permit.

3. Contractor is required to relist the Fire Alarm system as required to Steamboat Springs Fire Department.

1.3 SUBMITTALS

- A. Procedure - prepare and make submittals listed in accordance with Division 1, "Submittals" as required by Local Department of Fire.
- B. Product Data - submit manufacturer's specifications, recommendations, and installation instruction for use intended. The data shall include but is not limited to the following:
 1. Control panels
 2. Cabinets
 3. Manual stations
 4. Batteries
 5. Battery charger
 6. Smoke sensors
 7. Installer's training history
 8. Visual alarms
 9. Audio/visual alarms
 10. Addressable interface devices
 11. Central processing unit
 12. Wiring conductors
 13. Wire connectors
 14. Thermal sensors
 15. Electromagnetic door hold-open devices
 16. Two-way voice communication system
 17. Manufacturer's recommended calibrated test method for smoke sensors and smoke detectors.
 18. Include Underwriters Laboratories or Factory Mutual listing cards for equipment provided.
- C. Drawings
 1. Detailed drawings for the fire alarm system shall consist of illustrations, schedules, performance charts, battery calculations, point lists, instructions, diagrams, and complete detailed drawings of the fire alarm system.
 2. A descriptive index of drawings in the submittal with drawings listed in sequence by drawing number.
 3. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.
 4. Floor plans drawn to a scale not less than 1/8 inch equals 1 foot which clearly show locations of devices, equipment, risers, panels, electrical power connections, approximate location of conduit runs, and other details required to clearly describe the proposed system.

5. A 1/4" scale plan view of the fire command center and security office with dimensioned layout of all equipment therein.
6. Location of control panels, detectors, supervisory switches, manual pull stations, visual/audible alarms and electrical devices. Clearly and completely indicate the function of the control panel and devices. Indicate conduit routing and sizes, and the number of conductors contained in each. Indicate points of connection and terminals used for electrical field connections in the system, with a wiring color code. Indicate termination points of devices and indicate the interconnection of modules required for proper operation of the system. Indicate interconnection between modules and devices. Control diagrams shall be supplemented with a narrative description of the system. Point-to-point wiring diagrams shall indicate control panel wiring and make and model of devices and equipment. Signal circuit diagrams shall show current draw and load by device and by circuit.

D. Design Data

1. Battery standby power requirements calculations.
2. Submit design calculations for the system substantiating battery standby power requirements, calculations showing battery capacity and supervisory and alarm power requirements.

E. Field Test Reports

1. Preliminary and acceptance tests.
2. Include the control panel and initiating and indicating devices, a unique identifier for each device with an indication of test results, and signature of the factory-trained technician of the control panel manufacturer and equipment installer. With reports on preliminary tests, include printer information.

F. Record Drawings

1. Upon completion, and before final acceptance of the work, submit a complete set of CADD generated as-built drawings for the fire alarm system, including components and any other associated appurtenances. Include as-built circuit diagrams complete with conductor color codes and a listing of initiating device locations and fixing voltage for each. Submit an electronic set of all documentation. Submit as-built drawings in addition to the record drawings required by Division 1, "Operation and Maintenance Data".
2. List of FACP alphanumeric address names
3. Request for formal inspection and tests
4. When tests have been completed and corrections made, submit a signed, dated certificate with a request for formal inspection and tests.

G. Operation and Maintenance Manuals

1. Fire alarm control panel
2. Smoke and thermal sensors
3. Interface and control modules

4. Submit in accordance with Division 1, "Operation and Maintenance Data". Include current unit prices and source of supply for parts list, and a list of parts recommended by the manufacturer to be replaced after one year and three years of service. Include in the fire alarm control panel, full and comprehensive manufacturer's repair and service manuals.

1.4 QUALITY ASSURANCE

- A. Qualifications the manufacturer's authorized distributor must substantiate that within a 50-mile radius of the job site, there is an established agency which stocks a full complement of parts and offers full service during normal working hours on all equipment to be furnished and that the agency will supply parts without delay and at a reasonable cost.
- B. Qualifications of Installer: Prior to installation, submit data for approval showing that the Contractor has successfully installed addressable, analog intelligent interior fire alarm systems of the same type as specified herein, or that the Contractor has a firm contractual agreement with a subcontractor having such required experience. Include the names and locations of at least two installations where the Contractor or the subcontractor referred to above, has installed such systems. Indicate the type and design of each system and certify that each system has performed satisfactorily in the manner intended for a period of not less than 18 months. Submit names and phone numbers of points of contact at each site.
- C. Codes and Standards: Except as modified by governing codes and where more stringent standards are specified by the contract documents, comply with the latest applicable provisions and the latest recommendations of the following:
 1. National Fire Protection Association (NFPA): NFPA 70, "2020 National Electrical Code": NFPA 72, "National Fire Alarm and Signaling Code": NFPA 241, "Standard for Safeguarding Construction, Alteration and Demolition Operations": NFPA 101, "Life Safety Code".
 2. Factory Mutual (FM): FM 37825, "1952 Approved Guide".
 3. Underwriters Laboratories (UL): UL FPED, "Fire Protection Equipment Directory; UL 268, "Smoke Detectors for Fire Protective Signaling Systems;" UL 164, "Control Units for Fire Protective Signaling Systems, UL 197/ANSI, "Codes applicable to Americans with Disabilities Act Compliance", "Testing for Fire Resistive Cables" UL 2196, "Cables for Power-Limited Fire-Alarm Circuits" UL 1424.
 4. Americans with Disabilities Act
 5. Local and City Codes and Amendments.
 6. International Building Code, IBC-2018.
 7. International Fire Code, IFC-2018.
- D. Federal Specifications Compliance: Comply with FED-STD-595, "Colors used in Government Procurement".
- E. Guarantee - all components, parts and assemblies supplied by the manufacturer shall be guaranteed against defects in materials and workmanship for a period of 12 months upon

acceptance. Warranty service shall be provided by a trained specialist of the equipment manufacturer. The specialist shall be based in a fully-staffed branch office located within 50 miles from the job site.

- F. Testing - conduct a total system test for Architect/Engineer and Local Fire Department. Tests shall include as a minimum.

1. Verify operation of all manual pull stations and detectors.
2. Verify line supervision of each initiating and indicating circuit.
3. Verify the Class A operation of each initiating circuit.
4. Verify operation of all indicating devices.
5. Verify operation of all alarm initiated function.
6. Perform smoke test(s) as directed by the Local Fire Department.

The Engineer, Owner and Architect shall be advised a minimum of five working days before each test.

- G. All equipment provided as part of this section shall be the product of a single fire alarm equipment manufacturer. Interiors renovations scope shall match the base building fire alarm system to ensure interface between the rest of the building fire alarm systems.

- H. Equipment and devices shall be from a manufacturer who has been manufacturing similar products for a minimum of 5 years. Furnish materials and equipment that are current products of one manufacturer regularly engaged in the production of such equipment.

- I. Regulatory Requirements

1. Devices and equipment for fire alarm service shall be listed by Underwriters Laboratories, Inc. and listed in UL FPKD or approved by Factory Mutual and listed in FM P7825. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement.

- J. Requirements for Fire Protection Service

1. Equipment and material shall have been tested by Underwriters Laboratories, Inc. and listed in UL FPKD or approved by Factory Mutual and listed in FM P7825. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement.

- K. Standard Products

1. Materials and equipment shall be standard new products of a manufacturer regularly engaged in the manufacturer of such products. Select material from one manufacturer, and not a combination of manufacturers, for any particular classification of materials.

L. Modification of References

1. In NFPA publications referred to herein, consider advisory provisions to be mandatory, as though the word “shall” had been substituted for “should” wherever it appears; interpret reference to “Authority Having Jurisdiction”.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Protect equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, and other contaminants.

1.6 SPARE PARTS

- A. Spare parts shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be suitably packaged and identified by nameplate, stamping or tagging. Furnish the following:
 1. Four keys or tools for resetting manual systems.
 2. Four keys for locks of control panels or cabinets.
 3. Three (bases and heads) of each type smoke (area and duct) and thermal sensors.
 4. Three of each type monitor module.
 5. Three of each type control module.
 6. Three fuses of each type provided. Spare fuses shall be mounted in the fuse holder located inside each control panel.
 7. One of each type audio/visual device.
 8. One of each type visual device.

PART 2 - PRODUCTS

2.1 SYSTEM DESIGN

- A. Acceptable Manufacturers: Refer to Section 26 05 03.
- B. Scope
 1. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performing all operations in connection with the installation of the multiplex addressable Fire Alarm System (Class A) as shown on the drawings, as hereinafter specified, and as directed by the architect/engineer.

2. The Fire Alarm System shall consist of all necessary hardware and software equipment to perform the following functions:
 - a. Fire Alarm and Detection Operations.
 - b. Two-way Supervised Voice Communication Operations.
 - c. One-way Supervised Automatic Voice Alarm Operations.
 - d. Remote Manual and Automatic Control of elevators and remote monitoring of sprinklers.
 - e. Interface to the building network lighting control system.
3. Each item of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by the Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label. The Control Equipment for all Systems shall be listed under UL category UOJZ as a Single Control Unit.
4. The complete installation shall conform to the applicable sections of NFPA-72, NEC 760, Life Safety Code 101, and Local Authorities Having Jurisdiction.
5. Nodes as defined for this specification shall be intelligent, microprocessor-based devices that connect to, and handle network communications.
6. By programmable selection at each node:
 - a. The specific detail information of any point connected to any node in the network may be made accessible (declared public) to the network.
 - b. Points within each node shall be able to be grouped by area, type of device, type of function, or any other user selectable category, and custom labeled as a point list. A point list shall be acted upon as though it was a point for purposes of interaction with the node custom control program. Detail information shall not burden the point list messages, only the quantity and type of status shall be broadcast into the network.
7. The fire alarm system shall be provided with the primary monitoring host computer system for alarms, trouble, and supervisory indication located as shown on the construction documents. This host shall be U.L. listed for use with the fire alarm system. The host system shall be connected to the fire alarm control panels utilizing an RS-485, BACnet Level II, or equivalent network protocol on a twisted pair communication bus network.
8. Survivability: When wiring connecting the FSCS to any remote-mounted controlling device exceeds 100 feet; the wire shall be 2-hour rated in addition to being in conduit.

C. Alarm System

1. Furnish and install a fully field programmable/addressable analog fire detection system. The System shall determine the number and types of modules installed, the number of analog addressable loops, and all installed devices. It shall determine the type of device and the device number. The System shall use Style 4 (Class A) signaling line circuits and Style Z (Class A) indicating appliance circuits with individual device supervision and annunciation, primary and secondary supervision. Include control panels, central processing unit, microphone, signal zone selectors, manual pull stations, smoke sensors,

thermal sensors, addressable input interface devices, control and isolation devices, analog/addressable loop modules, audio/visual devices, visual devices, wiring, connections to devices, outlet boxes, junction boxes, and other necessary material for a complete operating system. System shall allow for loading or editing special instructions and operation sequences as required. System shall be site programmable to accommodate and facilitate expansion or changes. System shall be capable of generating the programming necessary to establish a fully functional general alarm system upon initialization. Software operations are to be stored in a non-volatile programmable memory. Loss of primary and secondary power shall not erase the instructions stored in memory. Selective input/output control functions based on ANDing, Oring, NOTing, timing and special coded operations shall be incorporated in the resident software programming of the system.

D. Job Site Changes

1. To accommodate and facilitate job site changes, initiating and indicating circuits shall be individually configurable on site to provide either alarm/trouble operation, alarm only, trouble only, current limited alarm, no alarm, normally closed device monitoring, a non-latching circuit or an alarm verification circuit.

E. Operations - New Construction

1. Display
 - a. Under normal condition, front panel shall display a "SYSTEM NORMAL" or equivalent message and the current time and date.
2. Sequence of Operation
 - a. Operation of manual stations or activation of area smoke sensors and thermal sensors including any manual or automatic initiating device shall cause the following unless noted otherwise:
 - 1) Annunciate device type, location by building, floor, circuit and time on FACP mounted alphanumeric annunciator and graphics panel.
 - 2) Trip communications dialer to alert monitoring agent/Fire Department. (Response will be required to reset FACP.)
 - 3) Building audio/visual devices to sound, except activation of a single smoke detector shall not sound devices until a second device of any type is activated, on devices programmed for Alarm Verification. Speakers and visual devices shall be activated in the area of alarm.
 - 4) Operate prioritized outputs to release magnetically held smoke doors throughout the building and as indicated on the contract drawings. Any designated normally locked doors shall be unlocked via an interface to the security and access control system.
 - 5) Operate prioritized outputs to signal the elevator recall functions.

- 6) Operate prioritized outputs to signal Building Automation Control system for controlling operation of dampers and fans for smoke evacuation and control, and integration of signal/control to all other systems.
- 7) Automatic Voice Evacuation Sequence shall perform as outlined below:

The audio alarm signal shall consist of a “Slow Whoop” alarm tone for a maximum of 15 seconds followed by automatic pre-selected voice evacuation messages. At the end of each voice evacuation message, the “Slow Whoop” alarm tone shall resume. The alarm tones shall sound alternately until the signal silence switch at the FACP has been operated.

- 8) Refer to Appendix in this section for additional information on the Sequence of Operation.

3. Abnormal Conditions

- a. Panel shall display the following information relative to the abnormal condition of a point in the system:
 - 1) Alphanumeric custom location label (minimum of 30 alphanumeric characters.)
 - 2) Type of device.
 - 3) Point status.

4. Alarm or Trouble Condition

- a. Pressing the appropriate FACP acknowledge button shall acknowledge the alarm or trouble condition. After the points have been acknowledge, the LEDs shall glow steady and the panel audible signal will be silenced. Total number of alarms, supervisory and trouble conditions shall be displayed along with a prompt to review each list chronologically. End of the list shall be indicated.

5. System Reset

- a. “System Reset” button shall be used to return to its normal state after an alarm condition has been remedied. The display shall step the user through the reset process.
- b. Should an alarm condition continue to exist, system will remain in an abnormal state. System control relays shall not reset. The panel audible signal and the alarm LED shall be on. The display will indicate the total number of alarms and troubles present in the system along with a prompting to review the points.

6. History Logging

- a. The control panel shall have the ability to store multiple events in an event buffer. These events shall be stored in a battery-protected memory. Events shall also be printed to the alarm printer.

7. Access Levels

- a. There shall be a minimum of four access levels provided for operators and supervisors via user-defined pass codes. Changes to pass codes shall be made only by authorized personnel.
- b. Should an invalid code be entered the operator shall be notified with a message.
- c. Access to a level will only allow the operator to perform actions within that level and actions of lower levels, not higher levels.
- d. The following functions shall have access levels associated with them:
 - 1) System Reset
 - 2) Set Time/Date
 - 3) Manual Control
 - 4) On/Off/Auto Control
 - 5) Disable/Enable
 - 6) Clear Historical Log
 - 7) Change Alarm Verification
 - 8) Program Update

8. Detection Operation (Smoke Sensors)

- a. Smoke sensors shall be smoke density measuring devices having no self-contained alarm set point (fixed threshold.) The alarm decision for each sensor shall be determined by the fire alarm control panel. The control panel shall determine the condition of each sensor by comparing the sensor value to the stored values.
- b. Control panel shall maintain a moving average of the sensors' smoke chamber value to automatically compensate (move the threshold) for dust and dirty conditions that could affect detection operations. System shall automatically maintain a constant smoke obscuration sensitivity for each sensor (via the floating threshold) by compensating for environmental factors. Smoke obscuration sensitivity shall be adjustable at least twice a day and within UL 26B window (0.5 percent to 4.0 percent) to compensate for any environment.
- c. System shall automatically indicate when an individual sensor needs cleaning. When a sensor's percentage of compensation reaches a predetermined value, a "DIRTY SENSOR" trouble condition or similar display shall be audibly and visually indicated at the control panel for the individual sensor. Additionally, the LED on the sensor base shall glow steady giving a visible indication at the sensor location. To prevent false alarms, these "DIRTY" conditions shall in no way decrease the amount of smoke obscuration necessary for system activation.
- d. Control panel shall perform an automatic self-test routine on each sensor which will functionally check sensor sensitivity electronics and ensure the accuracy of the values being transmitted to the control panel. Sensors that fail this test shall indicate a trouble condition with the sensor location at the control panel.

- e. An operator at the control panel, having a proper access level, shall have the capability to manually access the following information for each initiating device:
 - 1) Primary status
 - 2) Device type
 - 3) Present average value
 - 4) Present sensitivity selected
 - 5) Sensor range (normal, dirty, etc.)
 - f. An operator at the control panel, having a proper access level, shall have the capability to manually control the following for each sensor:
 - 1) Alarm detection sensitivity values.
 - 2) Enable or disable the point.
 - 3) Control a sensor's relay driver output.
 - g. It shall be possible to program the control panel to automatically change the sensitivity settings of each sensor based on time-of-day and day-of-week (for example, to be more sensitive during unoccupied times and less sensitive during occupied periods.)
 - h. Control panel shall have the capability of being programmed for a pre-alarm or two-stage function. This function allows an indication to occur when, for example, a 3 percent sensor reaches a threshold of 2.5 percent smoke obscuration.
 - i. For increased smoke detection assurance, individually addressed smoke sensors shall be provided with field adjustable alarm verification. Only a verified alarm shall initiate the alarm sequence operation. System shall be initially set up with a 30-second verification period.
9. Detection Operation (Thermal Sensors)
- a. Thermal sensors shall be combination rate-of-rise/fixed temperature sensing. The alarm decision for each sensor shall be determined by the fire alarm control panel. The control panel shall determine the condition of each sensor by comparing sensor value to stored values. Sensor shall have the ability from the control panel to adjust its temperature setting.
 - b. Control panel shall maintain a moving average of the sensors' heat sensing value to automatically compensate (move the threshold) for dust and dirty conditions that could affect detection operations. System shall automatically maintain a constant heat sensing sensitivity for each sensor (via the floating threshold) by compensating for environmental factors.
 - c. System shall automatically indicate when an individual sensor needs cleaning. When a sensor's percentage of compensation reaches a predetermined value, a "DIRTY SENSOR" trouble condition or similar display shall be audibly and visually indicated at the control panel for the individual sensor. Additionally, the LED on the sensor base shall glow steady giving a visible indication at the sensor location. To prevent false alarms, these "DIRTY" conditions shall in no way decrease the amount of heat sensing necessary for system activation.

- d. Control panel shall perform an automatic self-test routine on each sensor which will functionally check sensor sensitivity electronics and ensure the accuracy of the values being transmitted to the control panel. Any sensor that fails this test shall indicate a trouble condition with the sensor location at the control panel.
- e. An operator at the control panel, having a proper access level, shall have the capability to manually access the following information for each initiating device:
 - 1) Primary status
 - 2) Device type
 - 3) Present average value
 - 4) Present sensitivity selected
 - 5) Sensor range (normal, dirty, etc.)
- f. An operator at the control panel, having a proper access level, shall have the capability to manually control the following for each sensor:
 - 1) Alarm detection sensitivity values.
 - 2) Enable or disable the point.
 - 3) Control a sensor's relay driver output.

F. Operations - Interiors Renovations

- 1. Sequence of Operation (Existing)
- 2. Abnormal Conditions (Existing to remain - include integration of new devices and new Fire Protection system)
- 3. Alarm or Trouble Condition (Existing to remain - include integration of new devices and new Fire Protection system)
- 4. History Logging (Existing to remain - include integration of new devices and new Fire Protection system)
- 5. Detection Operation (Smoke Sensors) (Existing to remain - include integration of new devices and new Fire Protection system)
 - a. Smoke sensors shall be smoke density measuring devices having no self-contained alarm set point (fixed threshold.) The alarm decision for each sensor shall be determined by the fire alarm control panel. The control panel shall determine the condition of each sensor by comparing the sensor value to the stored values.
 - b. Control panel shall maintain a moving average of the sensors' smoke chamber value to automatically compensate (move the threshold) for dust and dirty conditions that could affect detection operations. System shall automatically maintain a constant smoke obscuration sensitivity for each sensor (via the floating threshold) by compensating for environmental factors. Smoke obscuration sensitivity shall be adjustable at least twice a day and within UL 26B window (0.5 percent to 4.0 percent) to compensate for any environment.
 - c. System shall automatically indicate when an individual sensor needs cleaning. When a sensor's percentage of compensation reaches a predetermined value, a "DIRTY SENSOR" trouble condition or similar display shall be audibly and visually indicated at the control panel for the individual sensor. Additionally, the

LED on the sensor base shall glow steady giving a visible indication at the sensor location. To prevent false alarms, these "DIRTY" conditions shall in no way decrease the amount of smoke obscuration necessary for system activation.

- d. Control panel shall perform an automatic self-test routine on each sensor which will functionally check sensor sensitivity electronics and ensure the accuracy of the values being transmitted to the control panel. Sensors that fail this test shall indicate a trouble condition with the sensor location at the control panel.
- e. An operator at the control panel, having a proper access level, shall have the capability to manually access the following information for each initiating device:
 - 1) Primary status
 - 2) Device type
 - 3) Present average value
 - 4) Present sensitivity selected
 - 5) Sensor range (normal, dirty, etc.)
- f. An operator at the control panel, having a proper access level, shall have the capability to manually control the following for each sensor:
 - 1) Alarm detection sensitivity values.
 - 2) Enable or disable the point.
 - 3) Control a sensor's relay driver output.
- g. It shall be possible to program the control panel to automatically change the sensitivity settings of each sensor based on time-of-day and day-of-week (for example, to be more sensitive during unoccupied times and less sensitive during occupied periods.)
- h. Control panel shall have the capability of being programmed for a pre-alarm or two-stage function. This function allows an indication to occur when, for example, a 3 percent sensor reaches a threshold of 2.5 percent smoke obscuration.
- i. For increased smoke detection assurance, individually addressed smoke sensors shall be provided with field adjustable alarm verification. Only a verified alarm shall initiate the alarm sequence operation. System shall be initially set up with a 30-second verification period.

G. Primary Power

- 1. New Construction: Obtain primary power 120 VAC 60hz, at the emergency panel in the electrical room for new systems as indicated on plans. Primary power source shall be identified FIRE ALARM SYSTEM with a red and white engraved plastic sign permanently affixed to the face of the switch. Install lock clips on circuit breakers in the "ON" position.
- 2. Interiors Renovations: (Existing to remain - include integration of new devices and new Fire Protection system)

H. Auxiliary Power (Secondary Power)

1. New Construction: Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power shall be automatic and shall not cause transmission of a false alarm.
 - a. Batteries
 - 1) Provide rechargeable lead acid type with sufficient ampere-hour rating to operate the system under supervisory and trouble conditions, including audible trouble signal devices for 24 hours and audible and visual signal devices under alarm conditions for an additional 5 minutes. House batteries either within the control panel or in a separate substantial steel cabinet, and finish on inside and outside with enamel paint; equip with a non-corrosive base and cylinder lock keyed to match FACP. Separate cells to prevent contact between terminals of adjacent cells and between terminals and other metal parts. Locate cabinet to allow convenient viewing and servicing of the batteries. A separate cabinet shall have twice the volume of batteries it will contain. The battery cabinet, if provided, shall be identified FIRE ALARM SYSTEM BATTERY CABINET with a red and white engraved plastic sign permanently affixed to the face of the panel.
 - b. Battery Charger
 - 1) Provide solid state automatic float type, capable of recharging completely discharged batteries to fully charged condition in 24 hours or less. Locate charger within the control panel or within the battery cabinet. Provide voltmeter and ammeter to indicate battery voltage and charging current.
2. Interiors Renovations: Existing to remain unless otherwise noted - include integration of new devices and new Fire Protection system.

I. Wiring

1. Conductors
 - a. Provide in accordance with NFPA 70 and NFPA 72. Conductors shall be copper. Conductors for 120/208-Volt circuits shall be No. 12 AWG minimum; single conductors for low-voltage D.C. circuits shall be a minimum No. 18 AWG twisted, shielded with drain wire minimum. Conductors shall be color-coded. Provide wiring in electrical metallic tubing conduit in dry locations not enclosed in concrete or where not subject to mechanical damage. Conceal conduit in finished areas. Identify conductors within each enclosure where a tap, splice, or termination is made. Identify conductors by plastic-coated, self-sticking, printed markers or by heat-shrink type sleeves. Wire the alarm initiating and notification signal devices so that removal will cause the system trouble device to sound. Each conductor used for the same specific function shall be distinctively color-coded. Use two different

color codes for each interior alarm circuit; one for each loop. Each circuit color code wire shall remain uniform throughout circuit. Plenum rated cable can be used where approved by engineer and is concealed but accessible.

2. Terminations

- a. Connections, junctions and conductor terminations shall be made with screw terminals at risers only. Terminate strips everywhere except in control panels. Terminations with operating voltage of 50-Volts or more shall be provided with protective cover and shall be labeled with the voltage.

2.2 COMPONENT DESIGN

A. Colors

- 1. Provide finish colors under this section in accordance with FED-STD-595.

- B. Fire Alarm Control Panel (FACP) – Only required in New Construction projects. Interiors Renovation scope will utilize the existing fire alarm control panel and new NAC/SLC circuits shall be routed to interface with the existing panel.

1. Requirements

- a. FACP shall comply with the applicable requirements of UL 864 10th Edition. Panel shall be modular, installed in a surface-mounted steel cabinet with cylinder lock. The door shall be hinged to allow access for service. Control panel shall be a neat, compact assembly containing components and equipment required to provide the specified operating and supervisory functions of the system. Control panel switches shall be within the locked cabinet. A suitable means shall be provided for testing the control panel visual indicating devices (meter or lamps.) Meter and lamps shall be plainly visible when the cabinet of the control unit is closed. Each initiating circuit shall be powered and supervised so that a signal on one zone does not prevent the receipt of signals from other zones. Loss of power, including any batteries, shall not require the reloading of a program from any source. Upon restoration of power, start-up shall be immediate, automatic and shall not require manual operation. Loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals. Enclosures shall be provided with ample gutter space to allow proper clearance between the enclosure and live parts of the panel equipment.
- b. Each FACP shall be intelligent, with its own microprocessor and memory. Each FACP shall be UL listed independently as a fire alarm control unit. Each FACP shall be capable of automatically updating the initial System Program to accommodate added or deleted devices on any analog circuit. Each FACP shall be capable of identifying and programming a General Alarm condition for all installed devices. The system shall be capable of identifying the number of analog addressable circuits, the number of devices on all circuits, the device type and

location. The System shall be capable of incorporating all new devices into the System program. System shall display at the control panel, the sensitivity of remote addressable photoelectric or ionization smoke sensor devices and thermal heat sensor devices. The system shall be capable of displaying 160 characters of system and user text (4x40 alphanumeric display). Control panel shall automatically return the normal mode after a predetermined time (1 hour) after being in the service mode. Addressable devices shall be individually identified by the system, and any quantity of addressable devices shall be in alarm at any time up to the total number connected to the system. Control panel shall be capable of supporting non-addressable as well as addressable devices. The Control panel shall be capable of supporting conventional zones in addition to analog/addressable circuits. The Control Panel shall provide for addressable remote conventional zones that are hardwired to any device addressability as well as remote sensitivity measurement shall be performed on the same pair or wires. System shall be capable of having multiple addressable devices in alarm simultaneously. FACP shall have a service mode to permit the arming and disarming of individual detection or output devices as well as manually operating output devices. Status of these devices shall be displayed upon command from the FACP. Control panel shall automatically return to normal mode in the event the panel remains unattended in the service mode. Control panel shall be able to receive and process alarms even in the service mode. FACP shall be capable of:

- 1) Smart Start auto initialization.
- 2) Smart Start Program Update.
- 3) Program all functions from the FACP front panel.
- 4) Counting the number of addressable devices within a "circuit" which are in alarm.
- 5) Counting "circuits" which are in alarm.
- 6) Counting number of addressable devices which are in alarm on system.
- 7) Differentiating among types of addressable devices such as ionization smoke sensors, photoelectric smoke sensors, thermal heat sensors, control elements, collective zone interfaces, point identification devices, and manual stations.
- 8) Assigning priorities to type of detectors, circuits or groups of detectors.
- 9) Provide remote point lit graphic map for all remote annunciator locations.
- 10) Indicate on FACP alphanumeric display, as a minimum, the following:
Building Number, Floor, Type of Device, and Device Address.
- 11) Supporting 1008 addressable devices.
- 12) Automatic evacuation voice message which operates as a two-channel system, allowing evacuation tones and voice messages be transmitted simultaneously to different zones. Visual alarms shall operate in unison with voice alarm system.

2. Control Functions

- a. Control functions shall be assigned on the basis of system initiation patterns of devices such as "ANDing" groups and "ANDing" types of devices.

3. Supervision

- a. FACP shall supervise each individual device on an initiating circuit such that trouble supervisory, normal, pre-alarm and alarm thresholds are individually annunciated. Each device on an addressable initiating circuit shall be checked to include the following: Sensitivity, response, opens, shorts, ground faults, functionality and status.

4. Reporting a Failure

- a. FACP shall report the failure of a device's transmitting components, open or shorted, on an addressable initiating circuit. Device shall be recognized and identified by location within the circuit to the specific devices, and other devices on the circuit shall continue to function properly.

5. Devices

- a. FACP shall report by specific device and address, any device which has been removed from an addressable initiating circuit, and shall not disrupt the operation of the remaining devices to function. The system shall be capable of sounding a Trouble if the device replaced is a different device type than the device removed.

6. Accessories

- a. FACP shall be completely equipped and be provided with 25 percent spare initiating and indicating circuits, including modules, enclosure space, terminal strips, internal electronic memory and other necessary accessories complete and ready to accept future circuits. The FACP shall be capable of automatically updating the System Program to adjust for such changes.

7. Power

- a. FACP shall provide power necessary for the devices connected to it, including relay and remote annunciators. Provide a green LED to indicate normal system power is functioning.

8. Hardware and Software

- a. Hardware and software which define system configuration and operation shall be provided. Memory data and operating system software shall be contained in a non-volatile memory.

9. Smoke Sensors

- a. Smoke sensors shall be provided with alarm verification with field-adjustable time from 0 to 60 seconds. System shall initially set up with a 30-second verification period.

10. Detector Sensitivity

- a. FACP shall be capable of measuring and adjusting the sensitivity of sensors. Provide an alphanumeric display to display custom messages and give readings of sensor sensitivity, sensor by sensor. It shall not be possible to change the sensor sensitivity from the FACP within maximum and minimum values as defined by the UL listing of the sensors. System shall be capable of listing sensor sensitivity settings on the printer for permanent record.

11. Smoke Obscuration Sensitivity

- a. Control panel shall maintain a moving average of the sensors' smoke chamber value to automatically compensate (move the threshold) for dust and dirty conditions that could affect detection operations. System shall automatically maintain a constant smoke obscuration sensitivity for each sensor (via the floating threshold) by compensating for environmental factors. The smoke obscuration sensitivity shall be adjustable within the UL 260 window (0.5 percent to 4.0 percent) to compensate for any environment.

12. Dirty Sensor Indication

- a. System shall automatically indicate when an individual sensor needs cleaning. When a sensor's percentage of compensation reaches a predetermined value, a "DIRTY SENSOR" or equivalent trouble condition shall be audibly and visually indicated at the control panel for the individual sensor. To prevent false alarms, these "DIRTY" conditions shall in no way decrease the amount of smoke obscuration necessary for system activation.

13. Self-Test Routine

- a. Control panel shall continuously perform an automatic self-test routine on each sensor which will functionally check sensor sensitivity and ensure the accuracy of the values being transmitted to the control panel. Any sensor that fails this test shall indicate a trouble condition with the sensor location at the control panel.

14. Resetting and Testing the System

- a. It shall be possible to test, reset and alarm silence from the FACP. New unacknowledged alarms and troubles shall be distinctively displayed on both the visual display and the printer and differentiated from previous alarm and troubles. System shall automatically indicate the total quantity of alarms and trouble which have occurred prior to reset at the control unit. No alarm or trouble indication shall be resettable until it has been acknowledged. It shall not be possible to reset the system until alarms have been acknowledged.

15. FACP Switches

- a. FACP switches shall allow authorized personnel to accomplish the following, independent of the main operating console:
 - 1) Trouble silencing switch which transfers trouble signals to an indicating lamp.
 - 2) Evacuation alarm silencing switch which, when activated during alarm, silences alarm devices and, upon clearing the alarm, causes operation of the system trouble signals until the switch is returned to the normal position. Upon activation of a second alarm while silenced, causes the evacuation alarm to re-sound. Operation of the switch when there is no evacuation alarm causes operation of the system trouble signals.
 - 3) Reset zones after initiating devices have been returned to normal.
 - 4) Perform a complete operation test of the microprocessor with a visual indication of satisfactory communications with each board.
 - 5) Test panel LEDs for proper operation without causing a change in the condition on any zone.

16. Field Programming Equipment

- a. Provide field programming equipment, software devices, software, computers and other equipment necessary, including interconnection cables to accommodate field software programming changes to be made by the owner to change device descriptions, sensitivity setting, control, device type and addition or deletion of devices.

17. Lockable Equipment

- a. Lockable equipment shall have a keyed lock. All devices and cabinets shall be keyed alike.

C. Manual Stations

- 1. Provide an addressable noncoded double action type with mechanical reset features. Locate stations as indicated. Stations shall be die cast aluminum semi-flush or surface-mounted. Surface-mounted boxes shall be painted the same color as alarm station. Mount stations with the base at 4 feet above finished floor and no more than 5 feet from any door, measured horizontally, as shown. Provide each station with screw-type terminals of proper number and type to perform functions required. Break-glass-front stations will not be permitted; however, a pull-lever, break-glass-rod type is acceptable. The manual alarm station shall require a key to reset or test.

D. Smoke Sensors

1. Provide analog addressable smoke sensors of the photoelectric type which shall communicate actual smoke chamber values to the system fire alarm control panel. Detectors shall be uniquely identifiable to FACP.
2. Sensors shall be listed to UL 268 and shall be documented compatible with the control equipment to which they are connected. Sensors shall be listed for both ceiling and wall-mount applications.
3. Each sensor base shall contain a LED that, when the control panel determines that a sensor is in the alarm or trouble condition, the control panel shall command the LED on that sensor's base to turn on steady, indicating the abnormal condition.
4. Sensor's electronics shall be immune from false alarms caused by electromagnetic interference and radio frequency interference.
5. All sensor addressing information shall be stored in the fixed base. Addressing information that is stored in the removable sensor is not acceptable.

E. Duct Smoke Detectors

1. Detectors in duct shall be analog addressable photoelectric type and listed by UL or FM for duct installation. Duct detectors shall be provided with approved duct housing, mounted exterior to the duct, and shall be provided with perforated sampling tubes extending across the width of the duct. Activation of duct detectors shall cause actuation of the fire alarm control panel in the same manner as other alarm initiating devices and in addition, cause all air handling units to be deactivated. Detector head shall contain amplifier switching circuitry. The amplifier switching circuit shall be entirely solid-state and operate with a nominal detector line voltage of 24-Volts D.C. Detectors to be equipped with screw terminals. Detector to be provided with indicating lamp and test switch and in test position bypass fan shutdown feature.

F. Thermal Sensors

1. Provide analog addressable thermal sensors of the combination rate-of-rise and fixed temperature type which shall communicate actual heat values to the system fire alarm control panel. Detector temperature setting shall be accomplished via the FACP. Detectors shall be uniquely identifiable to FACP.
2. Sensors shall be listed to UL 521 and shall be documented compatible with the control equipment to which they are connected. Sensors shall be listed for ceiling applications.
3. Each sensor base shall contain an LED that, when the control panel determines that a sensor is in the alarm or trouble condition, the control panel shall command the LED on that sensor's base to turn on steady, indicating the abnormal condition.
4. Sensor's electronics shall be immune from false alarms caused by electromagnetic interference and radio frequency interference.
5. Detectors shall be nominal 24 Vdc powered by initiating circuit.

G. Addressable Point Identification Device

1. The Point Identification Device shall be provided to connect single supervised conventional initiating contact type device such as water flow switches, tamper switches, single detectors, and other such devices to any of the two-wire intelligent analog loop cards. The Point Identification Device shall mount in a 4-inch square, 2 1/8-inch-deep electrical box and shall be capable of (Class "A") supervised wiring to the initiating device. The Point Identification Device shall contain an integral LED that annunciates module activation. The Point Identification Device shall provide address setting means switches and store an internal identifying code which the control panel shall use to identify the type of device.

H. Addressable Collective Zone Interface

1. The Collective Zone Interface shall be provided to connect supervised conventional initiating device or zone of supervised conventional initiating devices such as water flow switches, tamper switches, detectors, and other such devices to any of the three -wire intelligent analog loop cards. The Collective Zone Interface shall mount in a 4 11/16-inch-square, 3-inch-deep electrical box and shall be capable of (Class "A") supervised wiring to the initiating device(s). The Collective Zone Interface shall contain an integral LED that annunciates module activation. The Collective Zone Interface shall provide address setting means switches and store an internal identifying code which the control panel shall use to identify the type of device.

I. Addressable Control Element

1. The Addressable Control Element shall be provided to connect and supervise, conventional indicating device or zone of indicating devices that required an external power supply, such as horns, strobes to any of the (2) wire intelligent analog loop cards. The Control Element shall be capable of operating as a relay (dry contact form C,) to control door holders, and other such devices. Control Elements shall mount in a 4 11/16-inch-square, 3-inch-deep electrical box and shall be capable of (Class "A") supervised wiring to the indicating or control device. Control Element shall contain an integral LED that annunciates module activation. Control Element shall provide address setting means switches and store an internal identifying code which control panel shall use to identify the type of device. The addressable Control element shall be capable of providing feedback to the FACP for positive confirmation of the controlled devices activity.

J. Audio/Visual Alarms

1. Provide recessed and surface-mounted approved combination audio/visual alarm devices consisting of an electronic horn for use in an electrically-supervised circuit and a top-mounted integral flashing strobe light. The alarm horn shall have a sound rating of at least 96 decibels at 10 feet. Provide lamps of the flashing stroboscopic type, powered from the control panel alarm circuit. Lamps shall produce a minimum of 75 candela and be designed for A.D.A. compliance. Lamps shall be protected by a polycarbonate lens

and shall be labeled FIRE, and are to be mounted at 80 inches above the floor, unless noted otherwise on the drawings.

2. Visual alarms shall operate in unison with audio alarm system.

K. Visual Alarms

1. Provide flush and surface-mounted lamp assembly suitable for use in an electrically-supervised circuit. Provide lamps of the flashing stroboscopic type, powered from the control panel alarm circuit. Lamps shall produce a minimum of 75 candela and be designed for A.D.A. compliance. Lamps shall be protected by a polycarbonate lens and shall be labeled FIRE, and are to be mounted at 80 inches above the floor, unless noted otherwise on the drawings.
2. Visual alarms shall operate in unison with voice alarm system.

L. Electromagnetic Door Hold-Open Devices

1. Attach to the outlet boxes indicated. Device shall operate on power from the fire alarm control panel. Attach compatible magnetic component to the door. Under normal conditions, the magnets shall attract and hold the door open. Upon activation of the building fire alarm system, the devices shall be de-energized, thus releasing the doors on the circuit. Devices shall be designed for wall or floor mounting as required by location shown on drawings, complete with matching door plate, material and finish to match door hardware. Electromagnet operates from a 24 DC source, and requires no more than 0.070 watts to develop 25 lbs. holding force.

M. Fire Alarm Speakers - Medium Output

1. Speaker shall be a high efficiency, re-entrant type speaker suitable for voice and tone signals. Speaker shall be able to operate continuously without loss of signal for one hour in any ambient temperature environment from 150°F to -30°F. Speaker shall have a die cast housing and be resistant to water, corrosion, vibration and vermin and shall be impervious to damage from pointed objects. Speaker shall produce a sound pressure level of 87 dB measured at rated power (1 watt) ten (10) feet on axis at 1 KHz. Speakers shall have transformer taps of 2, 1, ½ and ¼ watts RMS audio power rating. Speaker shall be provided with pigtail leads for wiring terminations. Speaker shall be semi-flush mounted on a standard 4 x 4 electrical box with extension ring, or fully recessed as noted on the plans. All speakers in general space shall be medium output.
2. Where speakers are indicated to be installed flush mounted, provide with a white circular metal baffle with perforated holes meeting the Architect's approval.

N. Outdoor Fire Light and Horn

1. Outdoor fire lights and horn suitable for wet locations complete with high intensity flashing light and alarm horn as integral unit.
2. The electrical light source shall be sealed in silicone and protected by a Lexan lens. The word "fire" shall appear on the lens.
3. The minimum sound level shall be 95 dB at ten (10) feet.

O. Remote Indicator Lights

1. Remote indicator lights shall be lighted red when the associated device is in alarm. Light shall be mounted in a stainless-steel coverplate with the appropriate legend engraved thereon. Indicators shall be a highly visible red LED.

P. Nameplates

1. Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installations, installing Contractor's name and address, and the contract number provided on a new plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:
 - a. Fire Alarm Control Panels
 - 1) Furnish to obtain approval by the Engineer/Fire Department before installation. Nameplates shall be etched metal or plastic, permanently attached by screws to panels or adjacent walls.

Q. Wiring

1. Provide Wiring materials under this section as specified in division 26, "Wires and Cables", with the addition and modifications specified herein.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The work includes providing a new fully field programmable/addressable analog interior fire alarm and smoke detection system including associated equipment and appurtenances. Provide each system complete and ready for operation. Equipment, materials, installation, workmanship, inspection, and testing shall be in strict accordance with the required and advisory provisions of NFPA 70, NFPA 72 and NFPA 241, except as modified herein.
- B. Provide intelligent, analog addressable type manual pull stations, smoke sensors, thermal sensors, and audio/visual devices, including a stand-alone fire alarm control panel as located on the drawings and required by the fire department.
- C. Provide additional voice alarm speakers where sound level is not above 15dB above ambient noise level.
- D. Pre-inspection - examine areas and conditions under which work of this section is to be performed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION CRITERIA

- A. All fire alarm wiring shall be in conduit. All alarm and signal wiring shall be in accordance with the manufacturer's recommendations and installed in an approved raceway specified in Section 26 05 33.
- B. The contractors shall fully coordinate with all other trades for the proper wiring and control of all systems.
- C. VCS speakers shall be wired in parallel.
- D. Control panel, annunciators, standby power module must be mounted with sufficient clearance for observation and testing. Final arrangement and location must be approved by the Architect/Engineer and Fire Department
- E. Flexible connectors are to be used for all devices mounted in suspended lay-in ceiling panels. All conduit, mounting boxes, junction boxes and panels are to be securely hung and fastened with appropriate fittings to insure positive grounding throughout the entire system. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary functions will be permitted in fire alarm raceways.
- F. Conductors in cabinets must be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals must be numbered and coded.
- G. Wiring splices are to be avoided to the extent possible, and, if need, they must be made only in junction boxes which are to be painted fire-alarm red.
- H. Color codes must be used throughout. Transposing or changing color coding of wire will not be permitted. Wire nut-type connections are not acceptable. All conductors in conduit pull boxes or cabinets containing more than one wire must be labeled on each end with "E-Z Markers" or equivalent.
- I. Provide all necessary emergency power to the complete Fire Alarm System in accordance with the manufacturer's requirements.

3.3 PAINTING

- A. Paint exposed electrical, fire alarm conduit and surface metal raceway to match adjacent finishes in exposed areas. Paint conduit and surface metal raceways red in unfinished areas and above finished ceilings.

3.4 FIELD QUALITY CONTROL

A. Preliminary Tests

1. Conduct the following tests during installation of wiring and system components. Correct any deficiencies pertaining to these requirements prior to formal functional and operational tests of the system.
2. Ground Resistance
 - a. Measure the resistance of each connection to ground. Ground resistance shall not exceed 10 ohms.
3. Dielectric Strength and Insulation Resistance
 - a. Test dielectric strength and the insulation resistance of system interconnecting wiring by means of an instrument capable of generating 500-Volts D.C. and equipped to indicate leakage current in 1000 mega-ohms. For the purpose of this test, instrument shall be connected between each conductor on the line and between each conductor and ground at control panel and of line, with the other extremity open circuited and series-connected devices shunted or in place. System shall withstand test without breakdown and indicate a resistance of not less than 500,000 ohms, the measurement being taken after an electrification of not more than 1.0 minute with a dc potential of not less than 100-Volts nor more than 550-Volts. Dielectric tests shall be witnessed by Engineer or their designee.
4. Smoke and Thermal Sensor Tests
 - a. Prior to formal inspection and tests, clean and perform sensitivity tests on each smoke and thermal sensor. Clean the smoke and thermal sensors in accordance with the manufacturer's recommended procedures. Perform voltage activation sensitivity test on each sensor and record the results. Remove sensors with a sensitivity level above or below the UL accepted sensitivity range for that sensor and replace with new sensors. Present recorded data at the formal inspection for verification. Approved copies shall become part of the operations and maintenance manual for the fire alarm system.
5. Field Inspection and Test
 - a. Before final acceptance of the work, test each system to demonstrate compliance with the contract requirement. Each system shall be subjected, at minimum, to complete functional and operational tests including tests in place of each smoke sensor and detector, each thermal sensor, each manual station and visual and audio/visual device, tests of wiring supervision and tests of control panel functions. Preliminary tests shall be performed in accordance with manufacturer's published testing instructions and in accordance with NFPA 72. Furnish one extra Operations and Maintenance Manual with the formal request for final acceptance testing. The system shall be operational, with no trouble or alarm conditions, a minimum of 14

consecutive days prior to formal tests. Printer shall be operational during the preliminary tests and break-in period. Provide printer records with the request for formal inspection as evidence of completion of required preliminary test.

6. Formal Inspection and Test

- a. The Authority Having Jurisdiction will witness formal tests after receipt of written certification that preliminary tests have been completed and that the system is ready for final inspection. The system manufacturer's technical representative shall be present for the inspection and test. At minimum, preliminary tests shall be repeated and functional and operation tests conducted, as requested by the Architect/Engineer. Correct defects and conduct additional tests to demonstrate that the system conforms to contract specifications. Contractor shall provide two-way radios, personnel and test equipment required for conducting tests. Smoke detectors shall be tested using the manufacturer's calibrated test method. In addition, formal testing will require real smoke to be used to test smoke detectors. Canned smoke will not be permitted. Test equipment shall be turned over to the Authority Having Jurisdiction following test completion.

7. Manufacturer's Field Service

- a. Manufacturer's Representative
 - 1) Furnish the services of a factory-trained fire alarm system manufacturer's representative or technician, experienced in the installation and operation of the type of system being provided, to supervise the installation, testing, including formal testing, adjustment of the system, and instruction to the facility personnel. Furnish names and phone numbers of the factory-trained fire alarm system representatives or technicians.

B. Training

1. Equipment manufacturer shall provide 40 hours on site technical training to the owner or its representative (for two persons designated by Owner). Training shall allow for individual hands on programming, trouble-shooting and diagnostics exercises. Training shall occur within 2 months of system acceptance.
2. Also provide a minimum of 40 classroom hours of factory training in programming and use of the system for each of two people (designated by Owner). Provide room and board for trainees' during this period if training facility is located more than 30 miles from the project. Provide this training no less than six months and no more than eighteen months after building acceptance, as scheduled by Owner.

C. Adjustments

1. Equipment manufacturer shall provide necessary subsequent custom reprogramming to modify and adjust operations and individual identification nomenclature to the owner satisfaction four months after final system acceptance and twelve months after system

acceptance. Reprogramming is to be done at the job site and witnessed by the Authority Having Jurisdiction representative. Revision of as-built and record drawings shall be by the installing Contractor.

3.5 FIRE ALARM MATRIX

FIRE ALARM MATRIX																
	SYSTEM OUTPUTS	ACTIVATES FIRE ALARM SPEAKERS AND STROBES FOR ALL FLOORS	ACTIVATES ELEVATOR SHAFT RELIEF DAMPER.	RELEASE ELECTRIC LOCKS ON EXIT DOORS.	SHUT DOWN AFFECTED HVAC UNIT.	ACTIVATES EXTERIOR HORN/STROBE AT FIRE DEPARTMENT CONNECTION.	RELEASE MAGNETIC DOOR HOLDER CLOSING FIRE DOORS ON AFFECTED FLOOR.	RETURNS ELEVATORS TO PRIMARY RECALL (GROUND) LEVEL.	DISCONNECTS POWER TO AFFECTED ELEVATOR BANK.	RETURNS ELEVATORS TO ALTERNATE RECALL LEVEL (LEVEL 1).	ANNUNCIATES AT FIRE ALARM CONTROL PANEL.	SENDS ALARM TO FIRE DEPARTMENT VIA MONITORING STATION CONNECTION	CLOSES LOCAL FIRE/SMOKE DAMPER	ACTIVATES SUPERVISORY ALARM AT FACP AND MONITOR STATION	ACTIVATE COMMON TROUBLE ALARM	
SYSTEM INPUTS																
FIRE PROTECTION																
-AUTOMATIC SPRINKLER WATERFLOW OTHER THAN GROUND FLOOR		X		X		X	X	X			X	X				
-AUTOMATIC SPRINKLER WATERFLOW GROUND FLOOR		X		X		X	X			X	X	X				
-MAIN FLOW SWITCH		X		X		X	X				X	X				
-SPRINKLER TAMPER SWITCH														X		
-ICE PLANT REFRIGERATION PLANT LEAK DETECTION (PROMENADE BUILDING)		X		X		X	X				X	X		X		
SMOKE DETECTION																
-HVAC (AT UNIT)					X									X		
-RETURN FAN														X		
-ELEVATOR HOISTWAYS, MACHINE ROOMS		X	X	X			X	X			X	X				
-SMOKE DAMPER DUCT DETECTORS				X									X	X		
-ALL FLOOR AREA DETECTORS OTHER THAN 1 ST FLOOR		X		X		X	X	X			X	X				
-ALL FLOOR AREA DETECTORS 1 ST FLOOR		X		X		X	X			X	X	X				
HEAT DETECTION																
-ELEVATOR HOISTWAY AND MACHINE ROOM		X		X			X		X		X	X				
-MECHANICAL ROOM AND FLOOR AREA HEAT DETECTORS		X		X			X				X	X				

3.5 FIRE ALARM MATRIX

FIRE ALARM MATRIX														
SYSTEM INPUTS	SYSTEM OUTPUTS													
	ACTIVATES FIRE ALARM SPEAKERS AND STROBES FOR ALL FLOORS	ACTIVATES ELEVATOR SHAFT RELIEF DAMPER.	RELEASES ELECTRIC LOCKS ON EXIT DOORS.	SHUT DOWN AFFECTED HVAC UNIT.	ACTIVATES EXTERIOR HORN/STROBE AT FIRE DEPARTMENT CONNECTION.	RELEASES MAGNETIC DOOR HOLDER CLOSING FIRE DOORS ON AFFECTED FLOOR.	RETURNS ELEVATORS TO PRIMARY RECALL (GROUND) LEVEL.	DISCONNECTS POWER TO AFFECTED ELEVATOR BANK.	RETURNS ELEVATORS TO ALTERNATE RECALL LEVEL (LEVEL 1).	ANNUNCIATES AT FIRE ALARM CONTROL PANEL.	SENDS ALARM TO FIRE DEPARTMENT VIA MONITORING STATION CONNECTION	CLOSES LOCAL FIRE/SMOKE DAMPER	ACTIVATES SUPERVISORY ALARM AT FACP AND MONITOR STATION	ACTIVATES COMMON TROUBLE ALARM
MANUAL DEVICES														
-MANUAL PULL STATIONS 1 ST FLOOR	X		X		X	X			X	X	X			
-MANUAL PULL STATION OTHER THAN 1 ST FLOOR	X		X		X	X	X			X	X			
SYSTEM														
-OPEN CIRCUIT, GROUND FAULT, SHORT														X
-FIRE ALARM LOW BATTERY														X
-FIRE ALARM AC POWER FAILURE													X	
ICE PLANT REFRIGERANT SYSTEM														
-REFRIGERANT PURGE MODE ACTIVATED										X			X	
-REFRIGERANT TROUBLE													X	X
-REFRIGERANT OPERATING AS INTENDED										X				
-REFRIGERANT LOSS OF NORMAL POWER										X	X			X

END OF SECTION 28 46 00

SECTION 28 50 20 - EMERGENCY RESPONDER RADIO SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Per IFC section 510, all new buildings shall have approved radio coverage for emergency responders within the building based upon the existing coverage levels of the public safety communications systems of the jurisdiction at the exterior of the building, with the following exceptions:
 - 1. Where approved by the building official and the fire code official, a wired communication system may be permitted in lieu of an approved radio coverage system.
 - 2. Where it is determined by the fire code official that the ERRS is not needed.
 - 3. In facilities where the ERRS is required but the systems components could have a negative impact on the normal facility operations, the fire code official shall have the authority to accept an automatically activated ERRS.
- B. Contractor shall provide turnkey Emergency Responder Radio System (ERRS) to provide coverage for emergency responder 2-way radio signals within the entire building, compliant with all adopted codes including, but not be limited to IBC-916, IFC-510 and NFPA-72. Note, this system may also be referenced as Emergency / First Responder DAS or Public Safety DAS.
- C. Any reference to "DAS" within this specification section is for ERRS only. Cellular DAS (where applicable) is covered in another scope of work.
- D. Provide RF site survey to establish benchmark signal level. Coordinate timing of site survey with Owner and General Contractor.
- E. The following frequencies shall be supported and enhanced consistent with the results of the site survey and input from the local AHJ to confirm required frequencies. For pricing purposes, coverage for 700-800 MHz frequencies shall be considered the base / minimum requirement with alternate costs for adding 150 MHz and 450 MHz frequencies, where required.
 - 1. 700 MHz
 - 2. 800 MHz
 - 3. VHF / 150 MHz
 - 4. UHF / 450 MHz
- F. Coverage and signal strength shall be provided per International Fire Code section 510, including requirements for radio signal strength, secondary power, installation and testing procedures.

- G. The following design and installation scope is to be provided by the selected ERRS Contractor / Integrator, including but not limited to:
1. Donor antennas
 2. Active DAS components (bi-directional amplifiers, head-end, remote units, etc.)
 3. Passive DAS components (cabling, splitters, couplers, antennas, etc.)
 4. Power supplies and 24 hours UPS battery back-up (to support active equipment)
 5. Power circuits / outlets fed from base building electrical panels
 6. Raceway (conduits, sleeves, j-hooks, etc.)
 7. Penetrations (roof, floor, walls) and appropriate fireproofing and/or weather seals
 8. Fire-wrap to satisfy 2-hour pathway survivability for riser coax (as necessary)
 9. Fire alarm monitoring interface for 24/7 monitoring of system.

1.2 GENERAL REQUIREMENTS

- A. The term “provide” used throughout this specification and drawings shall mean “furnish, install, test, and certify”.
- B. Contractor shall fully coordinate with Authority Having Jurisdiction (AHJ) including all necessary system requirements, frequency allocations reviews and approvals with Building Department, Fire Department, Police Department, and/or other departments for determining system acceptance.
- C. Contractor shall coordinate project schedule, installation schedule, phasing and any other requirements deemed necessary with Owner, CM, and all necessary Trades to ensure successful completion of work.
- D. Contractor shall confirm if Union labor is required and include costs as applicable.
- E. Contractor shall design, furnish, install, and configure turnkey DAS passive and active equipment, system management and monitoring software. Work shall include all necessary DAS system components and installation thereof required including raceway, penetrations (roof, floor, walls), fireproofing, weather-sealing, conduit 2-hour fire-wrapping (riser locations), cable, cable terminals, transceivers/media converters, amplifiers, equipment, power supplies, battery back-up, AC power circuits, fire alarm monitoring, drywall repair, etc. for a fully operational and functional DAS.
- F. The DAS design shall be (virtually) developed, modeled and optimized using wireless computer software such as iBwave for establishing antenna locations based on electronic architectural drawings and various wireless frequency bands. Construction materials shall be inputted into the software program for structure, walls, floors, and ceilings.
- G. The DAS wireless coverage and signal strength shall be field tested and verified, certified, and guaranteed upon installation, compliant with IFC-510 testing requirements.

- H. The Contractor shall coordinate support systems requirements directly required by the DAS such as architectural, HVAC, electrical, and technology systems.
- I. The installation of the DAS system shall comply with all local building codes, and applicable rules and regulations of the AHJ, FCC, BICSI, EIA, IEEE, NEC, TIA, UL, IFC, NFPA and other industry standards, codes, and methods.
- J. All cabling shall comply with NFPA-72 pathway survivability requirements as adopted by the local AHJ. Specifically, Contractor shall confirm if AHJ considers building fully sprinkled and if there are any exceptions to the level-1 pathway survivability requirement. (Note: to comply with level-1 pathway survivability, all cabling shall be routed in metallic conduit, thus use of j-hooks or routing cable in cable tray is not allowed, unless specifically approved by the AHJ.)
- K. All riser coax cables shall be routed within 2-hour rated enclosure to comply with NFPA-72 pathway survivability. Contractor shall confirm if Telecom and Electrical riser rooms are 2-hr rated or not. If riser rooms are not 2-hour rated spaces, all riser coax shall be installed in conduit that is wrapped with multiple layers of 3M (or equivalent manufacturer) fire wrap, as directed per manufacturer requirements. Additionally, splitters that tap off of riser coax shall be installed in pull-box that is also wrapped with fire wrap.
- L. Plenum rated cable is required for all horizontal cable runs.
- M. DAS head-end equipment and remote units shall be installed in NEMA-4X enclosures

1.3 SUBMITTALS

Product Data: The DAS Product Data Submittal shall be submitted for review and approval by AHJ prior to starting any work. Copies shall be provided to ME Engineers for reference only. Information shall include detailed parts list for all components and manufacturer's product data for each component to be installed.

- A. Virtual Wireless Model: After project award, provide plan drawings based on architectural background or model indicating device and antenna placement based on wireless modeling computer software. Construction materials shall be inputted into the software program for structure, walls, floors, and ceilings as well as radio frequencies, zones, and capacity to help predict coverage and placement of antennas and associated coverage patterns. Information submitted shall include coverage drawing (heat map) as well as placement of antennas, equipment, cable and conduit routing, reflected ceiling plan layer, etc. Models shall be developed using iBwave or equivalent industry recognized software. Drawings shall be submitted for review and approval by AHJ prior to starting any work. Copies shall be provided to ME Engineers for reference only.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements of installed systems as well as acceptance by AHJ.

- C. Commissioning: The Contractor shall complete commissioning of the system and issue a final report. Commissioning shall be performed upon completion of system, and after its testing and retuning. Report shall be completed and finalized by the Contractor prior to system acceptance by the Owner.
- D. Warranties: The Contractor shall provide a warranty on all parts, components, and labor. Warranty period shall start based on acceptance by Owner upon completion of all installation, testing and optimization.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: The installation supervisor for both installation and maintenance of units required for this Project must be an experienced installer who is an authorized representative of the DAS Vendor.
 - 1. Contractors shall have at least five (5) years of successful installation experience with projects utilizing wireless systems including DAS.
 - 2. The company shall be a certified installer of the DAS manufacturer, and shall provide a 1-year warranty on installation/applications.
- B. Electrical Components, Devices, and Accessories: These shall be listed and labeled as defined in NFPA 70, NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. All materials shall be Underwriters Laboratories (UL) Listed unless otherwise noted or required by AHJ.

1.5 CODES AND STANDARDS

- A. All work including materials and installation shall conform to all applicable sections of currently adopted editions of the codes and standards listed below or the codes, standards and specifications published by the organizations listed below:
 - 1. All applicable / adopted national, state and local codes.
 - 2. ANSI: American National Standards Institute (ANSI).
 - 3. ANSI/EIA/TIA standards as applicable to DAS.
 - 4. ASTM: American Society for Testing and Materials
 - 5. BICSI TDM Telecommunications Distribution Methods Manual (current edition).
 - 6. BICSI Wireless Design Reference Manual (current).
 - 7. Emergency Responder Requirements as determined by AHJ, Fire Department, Police Department, and Ambulance/EMS.
 - 8. ICEA: Insulated Cable Engineers Association
 - 9. IEEE: Applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.
 - 10. IEEE-1100-1999: Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.

11. International Fire Code
12. National Electrical Code
13. NESC: National Electrical Safety Code
14. NEMA: Applicable requirements of NEMA Standards/Pub No.'s OS1, OS2 and PUB 250 pertaining to raceways, outlet and device boxes, covers, and box supports.
15. NFPA-70/NEC: National Electrical Code.
16. NFPA-70B: "Recommended Practice for Electrical Equipment Maintenance" pertaining to installation of cable tray systems.
17. NFPA-72: National Fire Alarm and Signaling Code
18. UL Compliance: Applicable requirements of UL 50, UL 514-series, and UL 886 pertaining to electrical boxes and fittings.
19. UL Compliance: Applicable requirements of UL Standards No.'s 467, Electrical Grounding and Bonding Equipment", and 869 "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Standard 486A, "Wire Connectors and soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL-listed and labeled for their intended usage.

1.6 SEQUENCING AND HANDLING

- A. All work shall be reviewed and coordinated with the Owner and/or Construction Manager prior to commencing.
- B. DAS, infrastructure, and equipment are sensitive to environmental conditions including but not limited to temperature, dirt, dust, and water. The contractor shall ensure the storage and installation of all system components are sequenced and scheduled accordingly to prevent any damage, loss of performance, and warranty voiding.
- C. Installation shall be coordinated with all Ceilings, Structural, Electrical, HVAC, Plumbing, Fire Protection, and other trades to eliminate disruption and/or conflict with other systems.

1.7 WARRANTY

- A. Warranty periods shall be provided on the components noted below and as listed within this section. Contractor shall submit all standard manufacturer product warranty information, including warranty length for each major component, including but not limited to passive devices (antennas, splitters, couplers, etc.), cabling (coaxial, fiber, and power), active components (remote radios, head-end equipment, etc.) and power supplies (power plants, rectifiers, batteries, etc.).
- B. A warranty on the Work shall be provided by the Contractor. If, within warranty time period after the date of final acceptance by Owner of the installation or within such longer period of time as may be prescribed by law or by the terms of any applicable special warranty required by the Contract Documents or provided by a manufacturer, any of the work or equipment is found to be defective or not in accordance with the Contract Documents, the Contractor shall

correct it promptly including all parts and labor after receipt of notice from the Owner to do so unless the Owner has previously given the Contractor a written acceptance of such condition. This obligation shall survive termination of the contract. The Owner shall give such notice promptly after discovery of the condition. Such notice shall be provided by Owner representatives, to be identified, either verbally or in writing. Warranty period shall start based on acceptance by Owner upon completion, testing and acceptance of the installation by the Wireless Carriers.

- C. The cabling Manufacturer shall provide a warranty for all cable infrastructure components. This warranty shall cover all components including cable, terminations, patch panels, and wiring panels, etc. to maintain the specified performance and physical criteria. Any such components, link, or channel shall be replaced by the Manufacturer at no cost to Owner during this period. The Contractor and Manufacturer shall submit all information and documentation on Warranty.

1.8 INSTALLATION

A. General:

1. The Contractor shall examine areas and conditions under which DAS infrastructure is to be installed. Notify Owner, Architect, and Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
2. The Contractor shall be knowledgeable of work to be performed by other trades and take necessary steps to integrate and coordinate their work with other trades.
3. The Contractor shall verify space requirements and locations before starting cable installations and terminations. Inappropriate conditions shall be immediately reported to Construction Manager, Owner, Architect, and Engineer prior to initiating installation.
4. All DAS communications infrastructure shall be installed for optimal performance.
5. All DAS and communications infrastructure shall be installed to allow for easy additions, moves, and other changes in the future.
6. Final labeling scheme for all DAS and communications components shall be coordinated with the Owner and Engineer, prior to initiating work. Labeling scheme shall include but not be limited to communications rooms, cabinets, racks, cable terminal blocks and patch panels, antennas, outlets, cables, etc.
7. The Contractor is required to coordinate their efforts with the other trades and sub-contractor who may be working within the same vicinity to avoid conflict and lost time.
8. The Contractor shall supply all necessary tools, equipment, accessories, safety equipment, protective clothing, etc., as customary for the craft and necessary for the installation.
9. The contractor shall not install any component in a manner or condition that will void manufacturer and/or contractor warranty. Any such conditions that prevent an acceptable install shall be immediately reported to Construction Manager or General Contractor, Owner, Architect, and Engineer prior to initiating installation. All mis-installed components will be removed and replaced with new, appropriate components at the Contractor's expense. No additional cost will be submitted to Owner.

10. All equipment shall be installed in a neat and workmanlike manner, arranged for convenient operation, testing and future maintenance.

B. Raceway Installation:

1. Contractor shall comply with all industry codes and standards for DAS raceway installation, including but not limited to, appropriate conduit size, fill ratio, bend radii, number of bends and/or distance between pull-boxes, etc.
2. Fire seal all raceway penetration and openings to maintain fire rating after communications cables are installed.
3. Provide labels on all communications pull-boxes and junction-boxes.
4. Identify conduits at cable tray end by architectural room number.

C. Cable Installation: The following procedures shall apply to cable installation:

1. All distribution cable, backbone cable, horizontal cable, and antenna cable must be plenum rated.
2. All DAS and communications cables routed within Telecom Rooms shall be bundled and combed to provide a neat and organized appearance, per industry standards.
3. Install cables concealed in accessible ceilings. Install cables according to manufacturer's recommended installation practices using approved hangers at a maximum spacing of every 48 inches (1.2m), where deemed acceptable by AHJ.
4. Cable bends shall not be less than that recommended by the manufacturer of the cable. Do not exceed manufacturer's minimum bending radii and other cable requirements.
5. The contractor shall not install any cable in conduits that does not have the appropriate protect bushings on conduit ends.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
7. All exposed conduit routing shall be coordinated with the Architect prior to installation. Contractor shall not route any cable exposed to view. Exposed cable (when allowed by AHJ) shall only be routed in cable trays or in j-hooks above accessible ceiling.
8. Care shall be taken so as not to damage cable during the installation process and that the manufacturer's and industry standard's pull tension specification is not exceeded.

D. Antenna Installation: The following procedures shall apply to antenna installation:

1. All antenna locations shall be coordinated with ME Engineers prior to initiating any work.
2. Install antennas per manufacturer's requirements.
3. Contractor shall install antennas with all necessary supports to ensure safe installation and support to prevent falling.
4. Antennas shall be rated accordingly and as applicable for the installation type, location, condition, and application supported.

- E. Equipment Installation: The following procedures shall apply to equipment installation:
1. Install surge suppressors where ac-power-operated devices are not protected against voltage transients by integral surge suppressors specified in UL1449. Install surge suppressors at the devices' power-line terminals. Comply with Division 26 Section "Transient Voltage Suppression."
 2. Mount electronic equipment in the types of cabinets recommended by manufacturer. Group related items in methodical sequence.
 3. Arrange equipment to facilitate access for maintenance and to preserve headroom and passage space.
 4. Interface DAS equipment with all base station equipment as required during installation period of DAS.
 5. Label all equipment and interfaces.
- F. System Management and Monitoring Software Installation: The following procedures shall apply to system management and monitoring software installation:
1. Coordinate all work with fire alarm contractor for interface to FACP for monitoring.
 2. The system management and monitoring software shall be fully set up, programmed, and configured.
- G. Design Coordination: All components proposed by the Contractor shall be coordinated with the Owner and Architect.
- H. Record documentation shall be submitted to the Owner by the Contractor at the completion of the DAS installation. The contractor shall submit all information necessary to operate and maintain the system including but not limited to the following:
1. As-Built Documents
 2. Operations and Maintenance Manuals
 3. Maintenance Schedule (with Company Contact Information)
 4. Troubleshooting Guide
 5. Product Data and Manufacturer Cut-Sheets
 6. Warranty Information and Contact
 7. Manufacturer's Product and Installation Certificate
 8. Log (troubleshooting, replacement, expansion, and replacements)
 9. Labeling Scheme

END OF SECTION 28 50 20

LIGHTING FIXTURE SCHEDULE							
TYPE	LAMP		DESCRIPTION	MOUNTING	MANUFACTURER	CATALOG NUMBER	COMMENTS
F1	5903 LUMENS, 55W, 2700K, 90+ CRI		TYPE IV MEDIUM BEAM DISTRIBUTION. PROVIDE ROUND 16" STRAIGHT POLE WITH POLE BRACKET FOR SINGLE FIXTURE AND ALL MOUNTINGS, ACCESSORIES AS REQUIRED. MARINE GRADE, DI-CAST ALUMINUM ALLOY, SS HARDWARE, PREMIUM GRADE CORROSION RESISTANT FINISH AND WET LOCATION RATING. POLE TO BE EQUIPPED WITH RECESSED, COVERED, WET RATED GFCI RECEPTACLE MOUNTED AT 24", OR NEAREST STANDARD HEIGHT OFFERED BY MANUFACTURER.	16" POLE MOUNT	WE-EF	FIXTURE: ASP534 LED 655-3526 BRACKET: 955-9370 POLE: 693-1230	POLE MOUNTED FIXTURE, SINGLE HEAD ORIENTED PER PLAN.
F2	(2) 5903 LUMENS, (2) 55W, 2700K, 90+ CRI		SIMILAR TO F1 EXCEPT DOUBLE POLE MOUNTED FIXTURES 180 DEGREES BACK TO BACK. POLE TO BE EQUIPPED WITH RECESSED, COVERED, WET RATED GFCI RECEPTACLE. MOUNTED AT 24", OR AT NEAREST STANDARD HEIGHT OFFERED BY MANUFACTURER.	16" POLE MOUNT	WE-EF	FIXTURE: (2) ASP534 LED 655-3526; BRACKET: 655-9371; POLE: 693-1230	POLE MOUNTED FIXTURE, DOUBLE-HEAD ORIENTED PER PLAN.
F3	THIS FIXTURE TYPE IS NOT USED.						
F4	3010 LUMENS, 27W, 2700K, 90+ CRI		CATENARY PENDANT LIGHT, SYMMETRIC BEAM SPREAD. WET RATED. PROVIDE ALL CATENARY POLES, CABLE, ANCHORS, TURN BUCKLES, AND OTHER MOUNTING ACCESSORIES AS REQUIRED FOR A COMPLETE INSTALLATION.	CATENARY SYSTEM	WE-EF	FIXTURE: AOP534 LED-FT 655-2522	CONFIRM DIMMING EQUIPMENT AND ACCESSORIES WITH THE PROJECT ELECTRICAL ENGINEER PRIOR TO PURCHASE. CONTRACTOR IS RESPONSIBLE FOR PROVIDING A CATENARY SYSTEM COMPLETE IN ALL RESPECTS AND CAPABLE OF CARRYING THE CUMULATIVE LOAD OF THE TYPE F4 FIXTURES, TYPE F9 FIXTURES. CONFIRM SYSTEM TO BE INSTALLED CAN BEAR THIS LOAD WITH MINIMAL "SAG" WITH PROJECT'S STRUCTURAL ENGINEER PRIOR TO PURCHASE AND INSTALLATION. SEE STRUCTURAL ENGINEERING DETAILS.
F5	SEE ARCHITECTURAL AND ELECTRICAL ENGINEERING DRAWINGS FOR ADDITIONAL INFORMATION						
F6	THIS FIXTURE TYPE IS NOT USED.						
F7			ROUND STRAIGHT 25', 6" DIA. POLE WITH BRACKET MOUNTED F7A FIXTURES AT 16' AND STAGGERED, CLAMP MOUNTED F7C FIXTURES AT 22' & 23', AND F7B FIXTURES AT 24' & 25'. SEE FIXTURE & BRACKET INFORMATION BELOW. PROVIDE FOR SEPARATE CONTROL OF FIXTURES F7A, F7B, F7C. POLE TO BE EQUIPPED WITH COVERED, WET RATED GFCI RECEPTACLE AT 24" AFF, OR NEAREST STANDARD MOUNTING HEIGHT OFFERED BY MANUFACTURER; AND AN ADDITIONAL, SPERATELY CONTROLLED RECPTACLE AT TOP OF POLE.	25' POLE MOUNT	WE-EF	110521 6" ROUND STRAIGHT POLE. BLACK.	LOCATED AT ICE SKATING RINK. RECEPTACLE FOR FUTURE POST-TOP MOUNTED PROJECTOR FIXTURE HAS NOT BEEN INCLUDED IN FIXTURE CUT. CONFIRM OWNER REQUIRES THIS OPTION PRIOR TO ORDERING.
	A	(2) 5903 LUMENS, (2) 55W, 2700K, 90+ CRI	(2) FIXTURES SIMILAR TO F1 EXCEPT DOUBLE BRACKET WITH FIXTURES 180 DEGREES BACK TO BACK.			FIXTURE: (2) ASP534 LED 655-3526 BRACKET: 655-9371	MOUNT TO POLE AT 16'
	B	(2) 6907 LUMENS, 56W, 2700K, RGBW LED	(2) ADJUSTABLE FIXTURES MOUNTED TO POLE WITH NARROW BEAM DISTRIBUTION (APPROXIMATELY 20 DEGREES), EQUIPPED WITH SNOOT AND HONYCOMB LOUVER, CONTROLLED BY DMX.			(2) FLC230 LED COLOR CHANGER 139-1913 / BLACK / NARROW / 667-9222 SNOOT / 667-8119 HONEYCOMB LOUVER.	SEE FIXTURE CUT FOR ADDITIONAL MOUNTING INFORMATION. FIXTURES SHALL BE AIMED DOWN AT ICE RINK. FINALIZED AIMING IN FIELD.
	C	(2) 6907 LUMENS, 56W, 2700K, RGBW LED	(2) ADJUSTABLE FIXTURES SIMILAR TO ABOVE, HOWEVER EQUIPPED WITH MEDIUM BEAM SPREAD (APPROXIMATELY 45 DEGREES) AND GLARE SHIELD. CONTROLLED VIA DMX.			(2) FLC230 LED COLOR CHANGER 139-1913 / BLACK/ MEDIUM / 667-9221 GLARE SHIELD	SEE FIXTURE CUT FOR ADDITIONAL MOUNTING INFORMATION. FIXTURES SHALL BE AIMED DOWN AT ICE RINK. FINALIZED AIMING IN FIELD.
F8	.2 WATT/2400K/LED LAMPS 9" ON CENTER		TREE ATTACHED LIGHT STRINGS WITH LED LAMP MODULES 9" ON CENTER, PERMANENTLY MOUNTED TO EXTERIOR COMMERCIAL GRADE GRAY WIRE. LAMPS TO BE DIMMABLE, REPLACEABLE, AND EQUIPPED WITH WATER-TIGHT SILICON CAPS. LENGTH OF LIGHT STRING TO BE 130' PER TREE. PROVIDE ALL ACCESSORIES REQUIRED TO MOUNT LIGHT STRINGS SECURELY TO TREE AND TO CONNECT TO DIMMING SYSTEM.	TREE MOUNTED	TOKISTAR	LIGHTSTRING – FLWG-210-WW-HB-WP	CONTRACTOR TO CONFIRM LENGTHS OF LIGHT STRINGS TO BE USED WITH LIGHTING DESIGNER UPON FINAL SELECTION OF TREE SIZES TO BE INSTALLED. CONTRACTOR TO CONFIRM DIMMING EQUIPMENT COMPATABILITY WITH PROJECT CONTROL SYSTEMS PRIOR TO ORDERING. SEE MOUNTING DETAILS IN LANDSCAPE DRAWINGS.
			HUB CONNECTORS (OR SIMILAR) FOR GANGING MULTIPLE LIGHT STRINGS IN TREE INTO A SINGLE FEED LINE TO REMOTE J-BOX.			HC-10 HUB CONNECTOR	SEE DETAIL 7.1 FOR INSTALLATION AND CAMOFLAGUING REQUIREMENTS.
			LED DRIVER 80 WATT/8 VOLT DC, WITH WATERTIGHT DIRECT BURIAL BOX THAT MATCHES MANUFACTURER'S REQUIREMENTS.			LDR 80-80	CONTRACTOR TO MATCH THE NUMBER OF DRIVERS NEEDED TO THE LENGTH AND WATTAGE OF LIGHT STRING USED, ON A TREE BY TREE BASIS.
F9	"S" TYPE, 1.6 WATT, 2400K LED		CATENARY ATTACHED HOLIDAY LIGHTING LIGHT STRING WITH UL WEATHERPROOF MEDIUM BASE SOCKET MOUNTED 24" ON CENTER TO 12/2 GAUGE, BLACK FLEXIBLE WIRE RATED FOR 25 AMPS AND OUTDOOR USE. EQUIP WITH DIMMABLE MEDIUM BASE 2400K LED LAMPS SUITABLE FOR EXTERIOR USE, AND ALL MOUNTING AND DIMMING ACCESSORIES RECOMMENDED BY THE MANUFACTURER. LENGTHS AS SHOWN ON PLANS.	CATENARY SYSTEM	PRIMUS LIGHTING	DECOSTRING – DSW-24-120-PLD-S14F-24K-160-LENGTH	CONFIRM DIMMING EQUIPMENT AND ACCESSORIES WITH THE PROJECT ELECTRICAL ENGINEER PRIOR TO PURCHASE. CONTRACTOR IS RESPONSIBLE FOR PROVIDING A CATENARY SYSTEM COMPLETE IN ALL RESPECTS AND CAPABLE OF CARRYING THE CUMULATIVE LOAD OF THE TYPE F4 FIXTURES, TYPE F9 FIXTURES. CONFIRM SYSTEM TO BE INSTALLED CAN BEAR THIS LOAD WITH MINIMAL "SAG" WITH PROJECT'S STRUCTURAL ENGINEER PRIOR TO PURCHASE AND INSTALLATION. SEE STRUCTURAL ENGINEERING DETAILS.
F10	16.5 WATT 2700K / 90+ CRI		DESCRIPTION: LED BOLLARD LIGHT - 37 5/8" HIGH, WITH SHIELDED 360 DEGREE DISTRIBUTION, DIE CAST ALUMINUM WITH BLACK MARINE GRADE FINISH, IP65 WET RATED AND EQUIPPED WITH 120-277 VOLT ELECTRONIC LED 0-10V DIMMING DRIVER.	BOLLARD	BEGA	99862-BLK FIXTURE MODULE / 99622-BLK BOLLARD TUBE / 79818 ANCHOR KIT	CONFIRM 2700K/90+ CRI IS AN AVAILABLE LAMP, MAKE MODIFICATION TO SPECIFIED COLOR IF NECESSARY.

ASP534 LED FIXTURE TYPE F1

655-3526

1/11



Description

IP55. LED post top luminaire with polycarbonate lens. LED board can be easily removed to upgrade. Integrated heat sinks. Easy removal and replacement of LED board. CAD-optimized OLC® PMMA lens for multi-layer illumination and superior glare control. Optional 2200 K version available. To be specified at time of ordering.

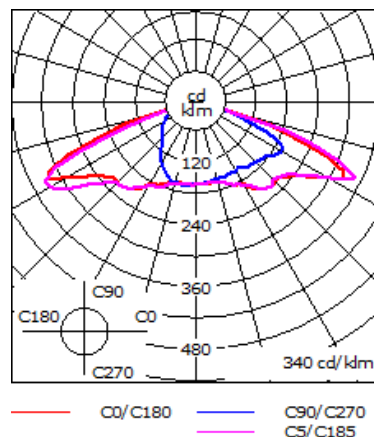
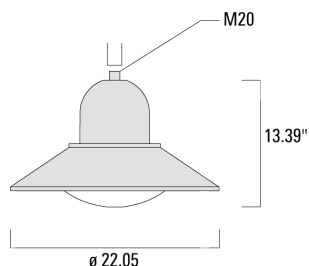
Beam Type	[R65] Type IV Medium
Light Source	LED-24/48W / 700 mA - 3000 K
CRI	
Gear Type	electronic gear
Nominal Luminous Flux (lm)	
LED Lumens	246 lm
LEDs	24
Total Lumens	5903 lm
Tj	85 °C
Delivered Lumens Flux (lm)	
LED Lumens	190.8 lm
Total Lumens	4578.9 lm
Ta	25 °C
Rated Input Power	55 W

ASP534 LED FIXTURE TYPE F1


655-3526

2/11

we-ef



Material Specification

Body:	Marine-grade die-cast aluminium alloy
Weight (lbs):	11.40
Lens:	Polycarbonate main lens
Colours:	<div><div></div> RAL9004 Black</div> <div><div></div> RAL9007 Grey Metallic</div> <div><div></div> RAL9016 White</div> <div><div></div> RAL8019 Dark Bronze</div>
 ETL	ETL, UL-1598 equivalent, CSA-C22.2#250.0. Suitable for Wet Locations.
Gasket:	Silicone rubber gasket
Fasteners:	PCS Polymer Coated Stainless Steel hardware
Ingress protection:	IP55
Impact protection:	IK10
Corrosion protection:	5CE
Mounting:	Luminaire requires a mounting bracket for mounting to wall or pole. Refer to mounting accessories for wall bracket and luminaire assembly brackets
Listings:	ETL listed. Suitable for wet locations.
Windage (EPA):	0.0898 m ²

Electrical Specification

Power supply:	Integral [ECG] electronic driver 120V-277V. 0-10V dimmable, to be specified with order.
Power factor:	> 0.9
Driver / Ballast:	Integral EC electronic converter

Lifetime

Ta=25°/40° L90B10 > 90000h

BUG Rating:

ASP534 LED

655-3526

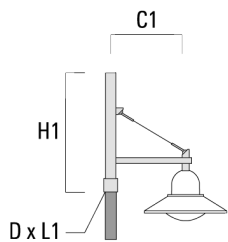
FIXTURE TYPE F1



9/11

■ DS1-500 Pole bracket, single

	C1	D x L	H1	L	Weight (lbs)
655-9370	20.08	2.99 x 3.15	28.54	2.99	8.60 lbs



Electrical Accessories

Button type photocell

Factory installed button type photocell. Photocell placed in post top head or side of bollard post. Photocell programmed for automatic dusk to dawn operation.

■ 697-8005 Button type photocell

Fusing

In-line fuse with fast acting circuit protection. Protects ballast from damage due to overcurrent.

■ 697-8001 Fusing

FIXTURE TYPE F1 AND TYPE F2

693-1230

Series AML-Z. STRAIGHT ROUND ALUM POLE.

Height: 16'-0"

we-ef

PROJECT DATA

PROJECT NAME
DATE
REFERENCE TYPE

FINISH
OPTIONS

LOCAL WE-EF REPRESENTATIVE

COMPANY
TELEPHONE
FAX
EMAIL

PRODUCT LINE DRAWING

PRODUCT DETAILS

Product Description	Product Code	H	D1	D2	Wall
AML-Z – 16-50-188	693-1230	16'-0"	Ø 5.0 "	Ø 5.0 "	.188

BASE PLATE DETAIL

Base size, Bolt circle, Conduit opening

23.62

PRODUCT DESCRIPTION

WE-EF PRODUCT ID. **693-1230. SERIES; AML-Z. STRAIGHT ROUND ALUMINUM POLE.**

MAIN FEATURES

Straight round aluminum pole. Chromated pre-treatment with superior powder coated finish in RAL color. Service door with tamperproof hardware. Base plate welded to tubular shaft. Spun aluminum base plate cover. **Specify suitable pole top tenon for intended brackets.**

Pole top tenon options: T3030: Ø 3.0 x 3.15" long tenon
T3040: Ø 3.0 x 4.0" long tenon
T3050: Ø 3.0 x 5.12" long tenon
T3080: Ø 3.0 x 7.87" long tenon
T3580: Ø 3.50 x 7.87" long tenon
T4280: Ø 4.25 x 7.87" long tenon

TECHNICAL DATA

DIMENSIONAL INFO & LOAD TABLE:

Max. E.P.A. at various MPH allows for 1.3 Gust factor and maximum luminaire weight of 100 lbs.

Effective Projected Area in square feet at:	Bolt circle	Bolt size	Base plate
70mph 80mph 90mph 100mph 110mph			
12.2 8.7 6.7 5.3 4.2	7.75-9.51	(4) 0.75" x 17"	9.61" s,q,

FINISH: Powder coat finish in Black RAL9004, White RAL9016, and Grey Metallic RAL9007. **Specify finish.**
Consult WE-EF color chart for other color options.

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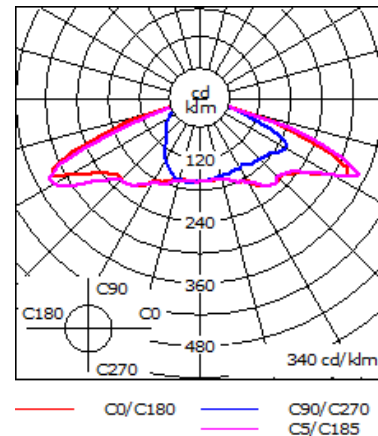
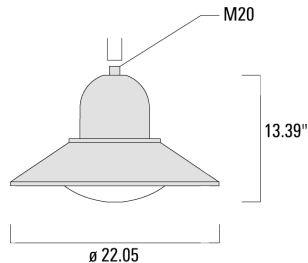
Due to continuous product improvement, specifications and data are subject to change without prior notification.



Description

IP55. LED post top luminaire with polycarbonate lens. LED board can be easily removed to upgrade. Integrated heat sinks. Easy removal and replacement of LED board. CAD-optimized OLC® PMMA lens for multi-layer illumination and superior glare control. Optional 2200 K version available. To be specified at time of ordering.

Beam Type	[R65] Type IV Medium
Light Source	LED-24/48W / 700 mA - 3000 K
CRI	80
Gear Type	electronic gear
Nominal Luminous Flux (lm)	
LED Lumens	246 lm
LEDs	24
Total Lumens	5903 lm
Tj	85 °C
Delivered Lumens Flux (lm)	
LED Lumens	190.8 lm
Total Lumens	4578.9 lm
Ta	25 °C
Rated Input Power	
	55 W



Material Specification

Body:	Marine-grade die-cast aluminium alloy
Weight (lbs):	11.40
Lens:	Polycarbonate main lens
Colours:	<div> <div></div> RAL9004 Black <div></div> RAL9007 Grey Metallic <div></div> RAL9016 White <div></div> RAL8019 Dark Bronze </div>
ETL	ETL, UL-1598 equivalent, CSA-C22.2#250.0. Suitable for Wet Locations.
Gasket:	Silicone rubber gasket
Fasteners:	PCS Polymer Coated Stainless Steel hardware
Ingress protection:	IP55
Impact protection:	IK10
Corrosion protection:	5CE
Mounting:	Luminaire requires a mounting bracket for mounting to wall or pole. Refer to mounting accessories for wall bracket and luminaire assembly brackets
Listings:	ETL listed. Suitable for wet locations.
Windage (EPA):	0.0898 m ²

Electrical Specification

Power supply:	Integral [ECG] electronic driver 120V-277V. 0-10V dimmable, to be specified with order.
Power factor:	> 0.9
Driver / Ballast:	Integral EC electronic converter

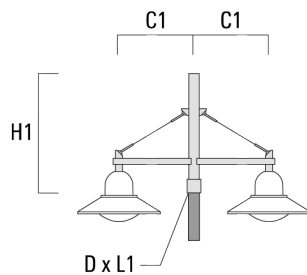
Lifetime

Ta=25°/40° L90B10 > 90000h

BUG Rating:

■ DS2-500 Pole bracket, double

	C1	D x L	H1	Weight (lbs)
655-9371	20.08	2.99 x 3.15	28.54	11.68 lbs



Electrical Accessories

Button type photocell

Factory installed button type photocell. Photocell placed in post top head or side of bollard post. Photocell programmed for automatic dusk to dawn operation.

■ **697-8005** Button type photocell

Fusing

In-line fuse with fast acting circuit protection. Protects ballast from damage due to overcurrent.

■ **697-8001** Fusing

FIXTURE TYPE F1 AND TYPE F2

693-1230

Series AML-Z. STRAIGHT ROUND ALUM POLE.

Height: 16'-0"

we-ef

PROJECT DATA

LOCAL WE-EF REPRESENTATIVE

PROJECT NAME
DATE
REFERENCE TYPE

COMPANY
TELEPHONE
FAX
EMAIL

FINISH
OPTIONS

PRODUCT LINE DRAWING

PRODUCT DETAILS

Product Description	Product Code	H	D1	D2	Wall
AML-Z – 16-50-188	693-1230	16'-0"	Ø 5.0 "	Ø 5.0 "	.188

BASE PLATE DETAIL

Base size, Bolt circle, Conduit opening

23.62

PRODUCT DESCRIPTION

WE-EF PRODUCT ID. **693-1230. SERIES; AML-Z. STRAIGHT ROUND ALUMINUM POLE.**

MAIN FEATURES

Straight round aluminum pole. Chromated pre-treatment with superior powder coated finish in RAL color. Service door with tamperproof hardware. Base plate welded to tubular shaft. Spun aluminum base plate cover. **Specify suitable pole top tenon for intended brackets.**

Pole top tenon options: T3030: Ø 3.0 x 3.15" long tenon
T3040: Ø 3.0 x 4.0" long tenon
T3050: Ø 3.0 x 5.12" long tenon
T3080: Ø 3.0 x 7.87" long tenon
T3580: Ø 3.50 x 7.87" long tenon
T4280: Ø 4.25 x 7.87" long tenon

TECHNICAL DATA

Max. E.P.A. at various MPH allows for 1.3 Gust factor and maximum luminaire weight of 100 lbs.

DIMENSIONAL INFO & LOAD TABLE:

Effective Projected Area in square feet at:					Bolt circle	Bolt size	Base plate
70mph	80mph	90mph	100mph	110mph			
12.2	8.7	6.7	5.3	4.2	7.75-9.51	(4) 0.75" x 17"	9.61" s,q,

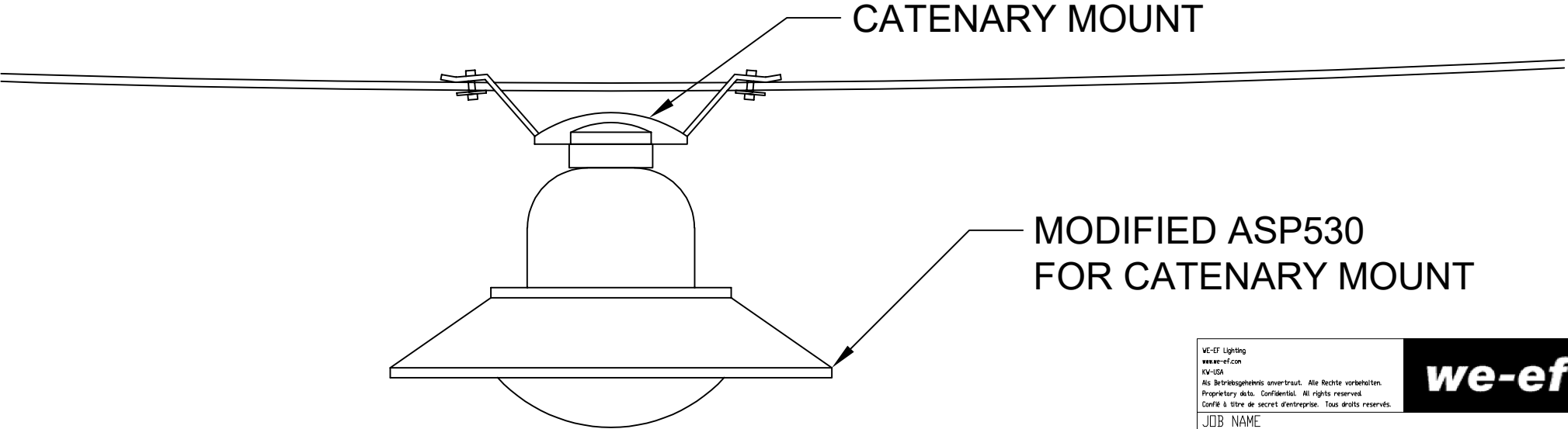
FINISH:

Powder coat finish in Black RAL9004, White RAL9016, and Grey Metallic RAL9007. **Specify finish.**
Consult WE-EF color chart for other color options.

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Due to continuous product improvement, specifications and data are subject to change without prior notification.

FIXTURE TYPE F4

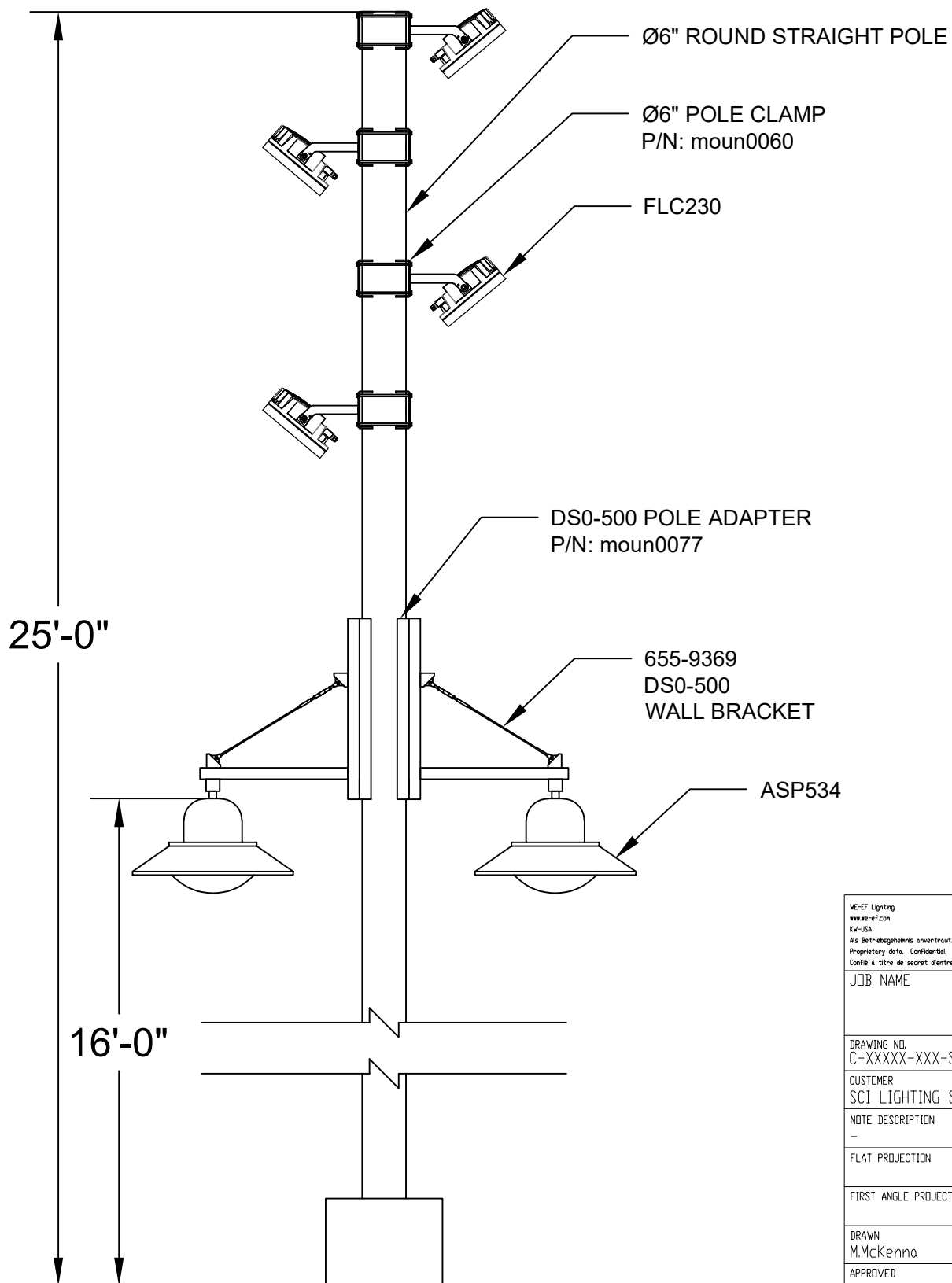


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JOB NAME STEAMBOAT			
DRAWING NO. C-XXXXX-XXX-SCILI-240321			
CUSTOMER SCI LIGHTING SOLUTIONS		SCALE .1 : 1 at A4	
NOTE DESCRIPTION -		TOLERANCE SEE TABLE	
FLAT PROJECTION		WEIGHT - lbs / - kg	
FIRST ANGLE PROJECTION		<div></div>	SURFACE FINISH -
DRAWN M.McKenna		DATE 03/24/2021	
APPROVED		DATE --/--/----	
#MODIFICATION/SBJCT. OF MODIFICATION/APPROVED BY/DATE - - - - - -			

TOLERANCE TABLE		
Angles	+/-	0.5 deg.
Hole Dia.	+/-	0.005"
0.X	+/-	0.050"
0.XX	+/-	0.030"
0.XXX	+/-	0.015"

NOTES:
 1)

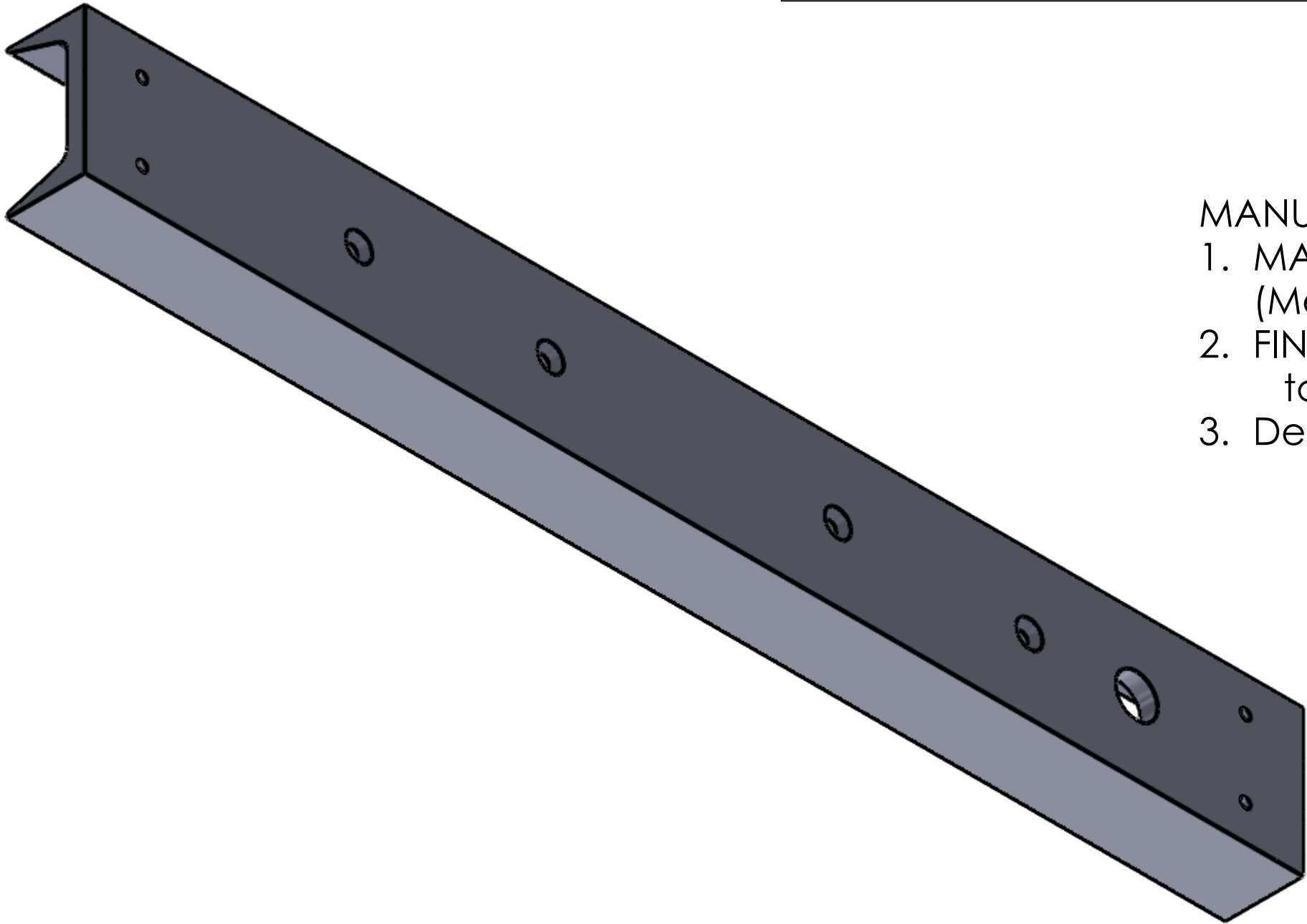
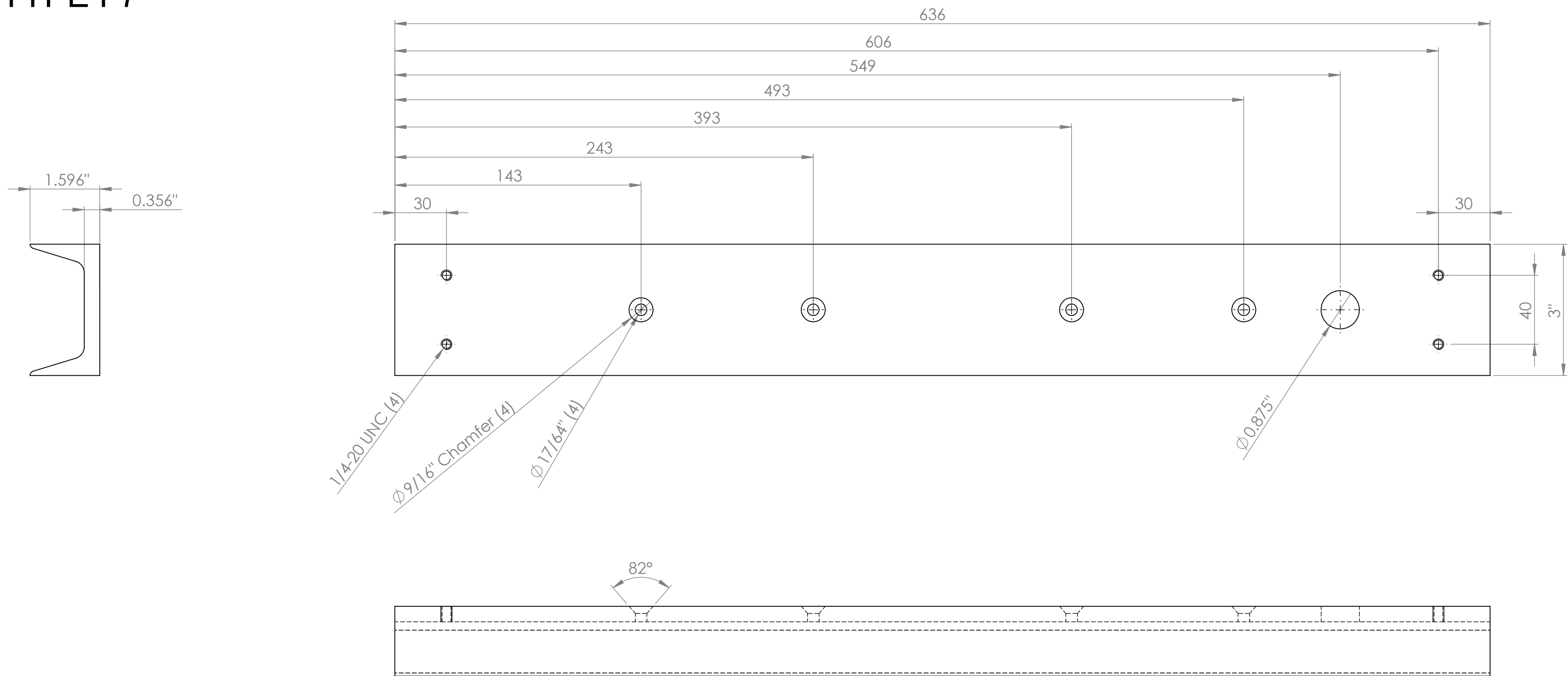
FIXTURE TYPE F7



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JOB NAME			
STEAMBOAT			
DRAWING NO. C-XXXXX-XXX-SCILI-110521			
CUSTOMER SCI LIGHTING SOLUTIONS		SCALE .1 : 1 at A4	
NOTE DESCRIPTION -		TOLERANCE SEE TABLE	
FLAT PROJECTION		WEIGHT - lbs / - kg	
FIRST ANGLE PROJECTION		SURFACE FINISH -	
DRAWN M.McKenna		DATE 05/11/2021	
APPROVED		DATE --/--/----	

TOLERANCE TABLE		
Angles	+/-	0.5 deg.
Hole Dia.	+/-	0.005"
0.X	+/-	0.050"
0.XX	+/-	0.030"
0.XXX	+/-	0.015"

FIXTURE TYPE F7



- MANUFACTURE NOTES:
1. MATERIAL: 3" x 1.596" x 0.356" Channel, 6061-T6 Aluminum (Metals Depot#: C33356, or similar)
 2. FINISH: UV Stabilized Polyester Powder Coat to Match RALXXXX
 3. Deburr All Edges and Holes 0.5" DIA. and Larger

WE-EF Lighting
www.we-ef.com
KW-USA
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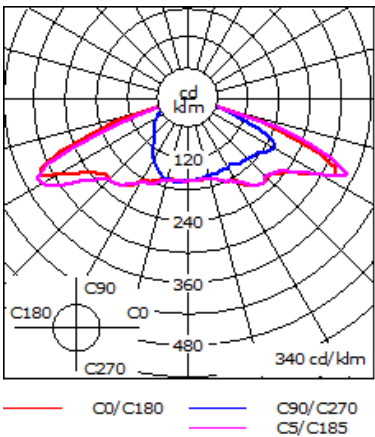
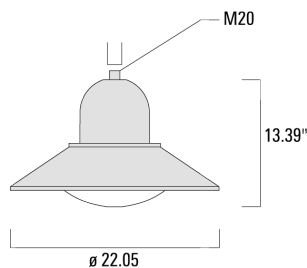
DESCRIPTION 1	
DS0-500 Pole Adapter Bracket	
DRAWING NO. moun0077	PART-ID moun0077
DESCRIPTION 2 -	SCALE A2
NOTE DESCRIPTION -	TOLERANCE SEE TABLE
FLAT PROJECTION	WEIGHT - lbs / - kg
FIRST ANGLE PROJECTION	SURFACE FINISH -
DRAWN B. Smith	DATE 12/17/2019
APPROVED -	DATE --/--/----
#MODIFICATION/SBJCT. OF MODIFICATION/APPROVED BY/DATE	
-	
-	
-	
-	
-	
-	
-	
-	
-	

TOLERANCE TABLE	
Angles	+/- 0.5 deg.
Hole Dia.	+/- 0.005"
0.X	+/- 0.050"
0.XX	+/- 0.030"
0.XXX	+/- 0.015"


ASP534 LED FIXTURE TYPE F7A

655-3526

2/11



Material Specification

Body:	Marine-grade die-cast aluminium alloy
Weight (lbs):	11.40
Lens:	Polycarbonate main lens
Colours:	<div><div></div> RAL9004 Black</div> <div><div></div> RAL9007 Grey Metallic</div> <div><div></div> RAL9016 White</div> <div><div></div> RAL8019 Dark Bronze</div>
 ETL	ETL, UL-1598 equivalent, CSA-C22.2#250.0. Suitable for Wet Locations.
Gasket:	Silicone rubber gasket
Fasteners:	PCS Polymer Coated Stainless Steel hardware
Ingress protection:	IP55
Impact protection:	IK10
Corrosion protection:	5CE
Mounting:	Luminaire requires a mounting bracket for mounting to wall or pole. Refer to mounting accessories for wall bracket and luminaire assembly brackets
Listings:	ETL listed. Suitable for wet locations.
Windage (EPA):	0.0898 m ²

Electrical Specification

Power supply:	Integral [ECG] electronic driver 120V-277V. 0-10V dimmable, to be specified with order.
Power factor:	> 0.
Driver / Ballast:	Integral EC electronic converter

Lifetime

Ta=25°/40° L90B10 > 90000h

BUG Rating:

FLC230 LED COLOR CHANGER

139-1913 (previous product code: 667-3327 – for reference only!)

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FIXTURE TYPES F7B AND F7C



Description

RGBW/RGBA Color Changer. IP66, Class I. IK07. Marine-grade, die-cast aluminum alloy. 5CE superior corrosion protection including PCS hardware. Silicone CCG® Controlled Compression Gasket. Safety glass lens. Two cable glands; one for power, one for DMX. Integral driver thermally separated. CAD-optimized optics for superior illumination and glare control. OLC® One LED Concept. Factory-installed LED circuit board with WE-EF Color Boost Technology. With Color Boost the targeted and selective control of individual channels or colors means that a higher power of the LEDs can be accessed than in total when all colors are simultaneously operated. The light output is thus maximized by targeted control of individual channels/colors. DMX interface. For the M20 cable gland for network- and DMX-connection, WE-EF recommends a multi-core cable for DMX and power, "Power PUR-SR 3x1,5 + DMX". Specify product with 7 Digit product code – Finish Color. (Other accessories, such as mounting, optical, and electrical, must be specified separately). Example: XXX-XXXX-9004 (Black) + XXX-XXXX (Accessories)

Beam Type	symmetric, medium beam [M]
------------------	----------------------------

Light Source	LED-12/48W - RGBW
---------------------	-------------------

CRI	20
------------	----

Gear Type	electronic gear
------------------	-----------------

Nominal Luminous Flux (lm)

LED Lumens	340 lm
------------	--------

LEDs	12
------	----

Total Lumens	4080 lm
--------------	---------

Tj	85 °C
----	-------

Delivered Lumens Flux (lm)

LED Lumens	267.1 lm
------------	----------

Total Lumens	3204.9 lm
--------------	-----------

Ta	25 °C
----	-------

Rated Input Power	50 W
--------------------------	------

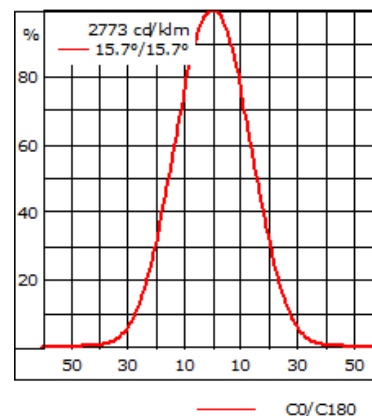
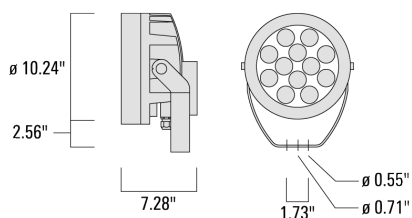
FLC230 LED COLOR CHANGER

139-1913 (previous product code: 667-3327 – for reference only!)

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we-ef

FIXTURE TYPES F7B AND F7C



FLC230 LED COLOR CHANGER





139-1913 (previous product code: 667-3327 – for reference only!)

we-ef

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FIXTURE TYPES F7B AND F7C

Material Specification

Body:	Marine-grade, die-cast aluminium alloy
Weight (lbs):	17.00
Lens:	Safety glass lens
Colours:	 RAL9004 Black  RAL9007 Grey Metallic  RAL9016 White  RAL8019 Dark Bronze



ETL

ETL, UL-1598 equivalent, CSA-C22.2#250.0.
Suitable for Wet Locations.



Color Boost

With RGBW/RGBA color mixing, the available electrical power of the projector is normally distributed evenly across all four channels. This means that a maximum of 25% of the electrical power is available to each channel. As a rule, however, a maximum of three channels are used for color mixing. This means that only a maximum of 75% of the electrical power is available to them. This is where WE-EF color boost technology comes in. When only three channels are used it distributes 100% of the electrical power to the three active channels, so that 33% instead of 25% of the total electrical power is available to each channel. Depending on the colours used, this increases the luminous efficacy by up to 40%.

Gasket:	Silicone CCG® Controlled Compression Gasket
Fasteners:	PCS Polymer Coated Stainless Steel Hardware
Ingress protection:	IP66
Impact protection:	IK07
Corrosion protection:	5CE superior corrosion protection system
Surge protection:	Integral 10kV Surge Protector
Listings:	ETL, UL-1598, CSA-C22.2#250.0. Suitable for Wet Locations. Meets ANSI C136.31 - 3G Vibration Rating for Bridge and Overpass Applications.
Windage (EPA):	0.684

Electrical Specification

Power supply:	Integral [ECG] electronic driver 120V-277V. 0-10V dimmable, to be specified with order.
Power factor:	> 0.9
Driver / Ballast:	Integral EC electronic converter with DMX Interface
Cable:	Two cable entry

Lifetime

Ta=25°/40° L90B10 > 90000h

FLC230 LED COLOR CHANGER

139-1913 (previous product code: 667-3327 – for reference only!)

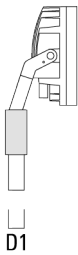


15/23

■ KF16-89/M16 Spigot Cap (Ø 3.5")

FIXTURE TYPES F7B AND F7C

669-9333

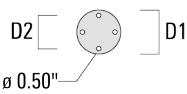


Surface Mount Canopy SMC

Suitable for mounting FLC200 series floodlight to any horizontal or vertical surface over a recessed junction box.

■ SMC-200

	D1	D2	Weight (lbs)
683-9329	10.83	9.25	7 lbs



Optical Accessories

Glare shield

Glare shield made from corrosion resistant aluminum. Inner surfaces matt black powdercoated.

FLC230 LED COLOR CHANGER

139-1913 (previous product code: 667-3327 – for reference only!)

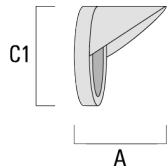
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■ ES-FLC230-LED

FIXTURE TYPES F7B AND F7C

	A	C1
667-9221	6.26	10.47

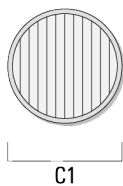


Linear spread lens

Broadens light distribution in one plane only. A maximum of one internal optical accessory.

■ IO-180-FLC230-LED

	C1
667-8119	7.80



Snoot

Framing snoot made from corrosion resistant aluminium. Provides all-round glare cut-off as well as effective framing of beam. Inner surfaces matt black powdercoated.

FLC230 LED COLOR CHANGER

139-1913 (previous product code: 667-3327 – for reference only!)

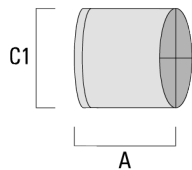
we-ef

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■ Snoot ET

FIXTURE TYPES F7B AND F7C

	A	C1
667-9222	6.3	10.47

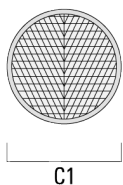


Wallwash lens

Specifically developed for the lighting of architectural surfaces, in combination with WE-EF [M] symmetric medium beam LED optics. Luminaires fitted with the IO-20 wallwash lens are typically positioned at $0.125 \times h$ away from the target surface and spaced up to $1.75 \times d$ apart: h = height of wall/target surface $d = 0.125 \times h$ = distance from the wall/target surface $s = 1.75 \times d$ = spacing between luminaires The IO-20 LED wallwash lens is factory-installed within the luminaire. The factory-sealed qualities and advantages of the luminaire are fully maintained. Not separately available. A maximum of one internal optical accessory.

■ IO-20-FLC230-LED

	C1
667-8118	7.83



Control

FLC230 LED COLOR CHANGER

139-1913 (previous product code: 667-3327 – for reference only!)

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we-ef

DMX Wireless

Modification for luminaires for wireless DMX data transmission

FIXTURE TYPES F7B AND F7C

■ DMX Wireless

430-0018

DMX Controller

IP20. DIN Rail system. Designed for either live or stand-alone control. Features one DMX universe, a USB connection, 128k flash memory for storing stand-alone programs. Recommended for up to 50 projectors. Not RDM ready and not available with external sensors. Includes power supply.

■ DMX Controller

400-9001

DMX Splitter

IP20. DIN Rail system. Takes the DMX signal and splits it electronically via maximum of 4 lines by copying the data stream. The splitter electrically isolates the signal. This will reliably block faults. The DMX signal is amplified to full strength again. RDM ready. Includes power supply.

■ DMX Splitter

400-9005



DMX Booster Box

IP66. Is designed to increase the DMX signal, which over a particular distance or number of projectors begins to decrease. RDM ready. Includes power supply. (Illustration shows booster without box)

FLC230 LED COLOR CHANGER

139-1913 (previous product code: 667-3327 – for reference only!)

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FIXTURE TYPES F7B AND F7C

■ DMX Booster Box

400-9006



DMX Termination Plug

IP68. Required for the last projector at the end of each line. Including resistor.

■ DMX Termination Plug

400-9008



DMX Plug and Socket

IP68. Suitable for shielded combination cable 3G1.5 mm² + 2 x 0.22 mm². For installation in soil, water and concrete; suitable protection must be provided.

FLC230 LED COLOR CHANGER

139-1913 (previous product code: 667-3327 – for reference only!)

we-ef

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FIXTURE TYPES F7B AND F7C

■ DMX Plug and Socket

400-9012



DMX Combination Cable

Flexible cable for DMX and power supply. 3 x 14AWG + 2 x 19AWG with Shield. Outer sheath PVC. Single wire PVC. Suitable for exterior use. For installation in soil, water and concrete; suitable protection must be provided.

■ DMX Combination Cable

400-9013



DMX Wireless Transceiver

IP67. Wireless transmission of the signal up to 300 m. 2.4 GHz. Max. Output power 100mW. Connection terminals max. AWG13. 85-264VAC / 47-70Hz / 3W.

FLC230 LED COLOR CHANGER

139-1913 (previous product code: 667-3327 – for reference only!)

we-ef

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■ DMX Wireless Transceiver

FIXTURE TYPES F7B AND F7C

400-9009



DMX Wireless Repeater

IP67. Amplifies and increases the range of the DMX signal. 2.4 GHz. Max. Output power 100mW. Connection terminals max. AWG13. 85-264VAC / 47-70Hz / 3W.

■ DMX Wireless Repeater

400-9010



DMX Controller (smart)

IP20. The Touch Panel is an intuitive and easy-to-use keypad for one DMX universe. Can store up to 36 scenes; alternatively, via a wheel scene mode, one of more than 16 million colours can be selected. Dimming and saturation function is also included. Recommended for up to 50 subscribers. Not RDM ready and not available with external sensors. Includes power supply.

FLC230 LED COLOR CHANGER

139-1913 (previous product code: 667-3327 – for reference only!)

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■ DMX Controller (smart)

FIXTURE TYPES F7B AND F7C

400-9002



DMX Controller (smart) - RDM ready

IP40. Digital interface module. IP20. DIN Rail system. The Touch Panel is an intuitive and easy-to-use keypad. The control module is Network and eDMX capable, cascadable. The Digital 4.3" capacitive touch screen, user interface customizable and custom graphic as background possible. Switch, slide and controller configurable. Vast interfacing potential (for further details on request. IR sensor for remote control and ambient temperature sensor. Equipped with SD card slot. Recommended for up to 50 subscribers. RDM ready. Includes power supply.

■ DMX Controller (smart) - RDM ready

400-9004



DMX Controller - RDM ready

IP20. DIN Rail system. Network and eDMX capable, cascadable. Designed for either live or stand-alone control for 1->2 DMX, 1->4 eDMX (must be specified at time of ordering). Features a USB connection and additional interfaces (MiDi, Serial, analog, digital). Further details on request. Equipped with SD card slot. Recommended for up to 50 subscribers. RDM ready. Suitable for external sensors. Includes power supply.

FLC230 LED COLOR CHANGER

139-1913 (previous product code: 667-3327 – for reference only!)

we-ef

23/23

■ DMX Controller - RDM ready

FIXTURE TYPES F7B AND F7C

400-9003



TOKISTAR Lightstrings

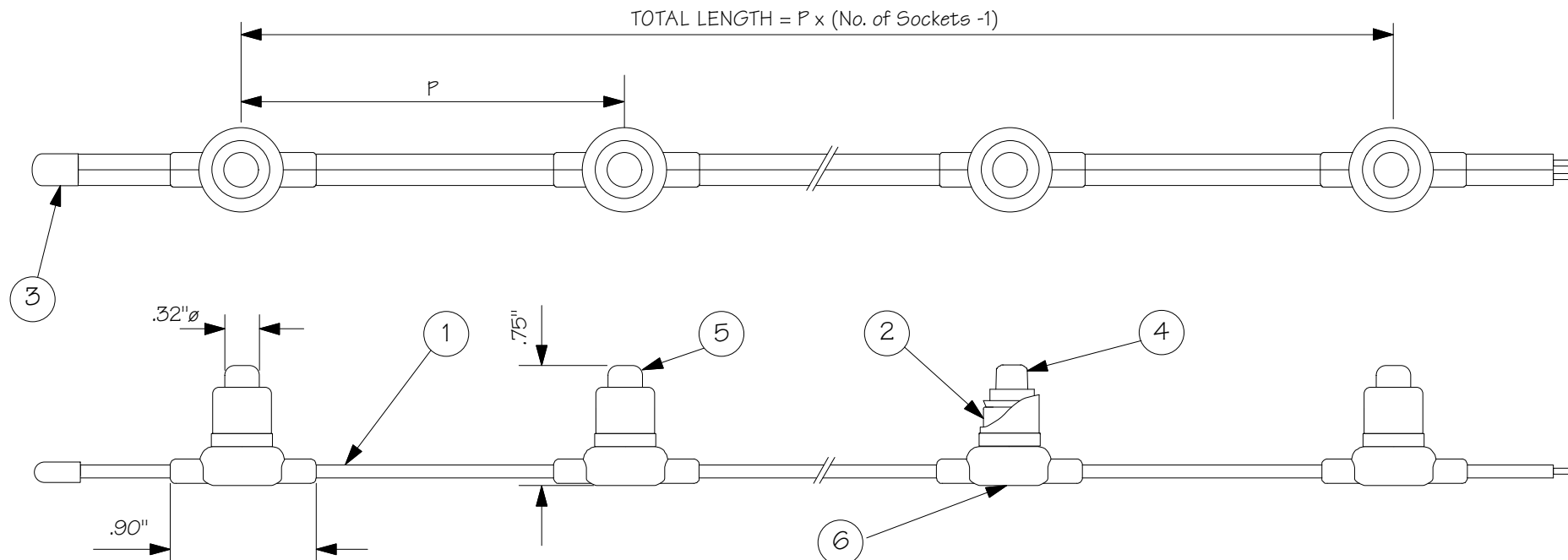
FIXTURE TYPE F8



TOKISTAR LIGHTING

FL SERIES-0.2 WATT TOKILEDS®

FIXTURE TYPE F8



CATALOG#	P (INCH)	MAX. LENGTH
FLBK-60-(LED CODE)-(WP)	2.4 ± .20	40 FT.
FLBK-110-(LED CODE)-(WP)	4.25 ± .20	63 FT.
FL(BK,WG)-160-(LED CODE)-(WP)	6.25 ± .20	75 FT.
FL(BK,WG)-210-(LED CODE)-(WP)	8.25 ± .20	87 FT.
FL(BK,WG)-310-(LED CODE)-(WP)	12.25 ± .20	106 FT.
FLBK-410-(LED CODE)-(WP)	16.25 ± .20	122 FT.

CABLE COLOR CODE: BK=BLACK, WG=WARM GREY
 WARM GREY AVAILABLE IN 6.25", 8.25" AND 12.25" ONLY
 WP=OPTIONAL SILICONE CAP FOR OUTDOOR USE

0.2 WATT TOKILEDS® 8VDC/25.0mA			
PART #	LED CODE	COLOR	LUMEN
TLED-LW-HB	LW-HB	2000K WHITE	???
TLED-WW-HB	WW-HB	2400K WHITE	2.4Lm
TLED-IW-HB	IW-HB	3000K WHITE	2.6Lm
TLED-WH-HB	WH-HB	6500K WHITE	3.2Lm



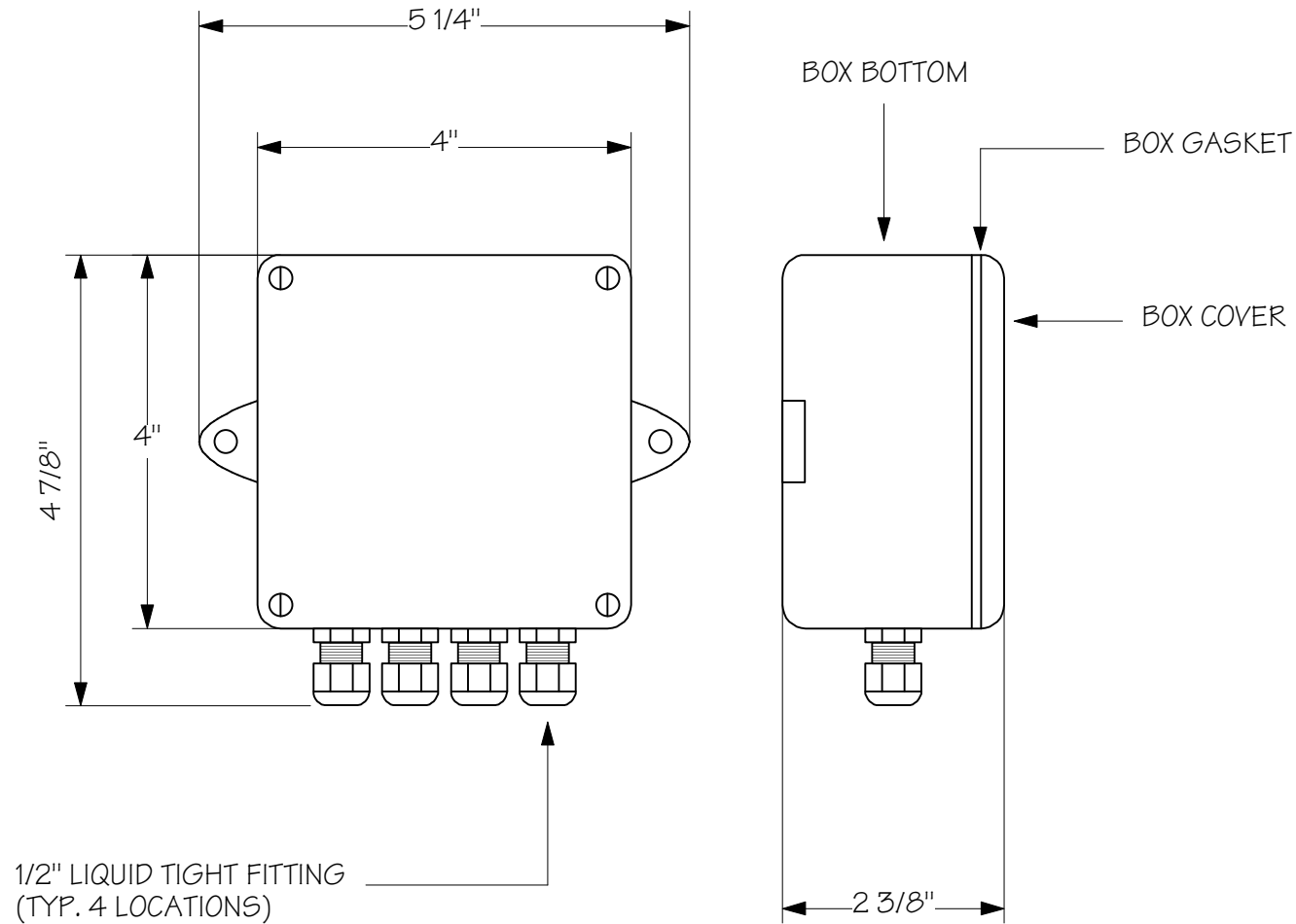
TOKISTAR LIGHTING INC.

1015 E. DISCOVERY LANE
 ANAHEIM, CA 92801
 TEL: 714 772 7005 FAX: 714 772 7014
 email: info@tokistar.com Website: tokistar.com

FL SERIES SUBMITTAL	NO.	PART	MATERIAL
CATALOG#: FL(BK,WG)-_-(LED CODE)-(WP)	1	WIRE	PVC INSULATION WITH #18 AWG X2
DATE: JANUARY 1, 2015	2	LAMP SOCKET	POLYCARBONATE WITH PLATED COPPER CONTACTS
DRAWN BY: R. CORDOVA	3	END CAP	PVC
SCALE: 1:1	4	LED	SOLID STATE LED
WEIGHT: 15g/ft.	5	SILICONE CAP	SILICONE (CLEAR)
	6	INSULATION	HOT MELT

HC-10 JUNCTION BOX

FIXTURE TYPE F8



TOKISTAR LIGHTING, INC.

1561 N. GEMINI PLACE
ANAHEIM, CA 92801

PH: 714-772-7005 FX: 714-772-7014

DESCRIPTION: HC-10 JUNCTION BOX

DATE: 5/29/2008

SCALE: NTS

DRAWING #: MR20080529-001

DRAWN BY: M. ROWSEY

LED Drivers

Tokistar's LDR8-40 is a 40 Watt Class 2 LED driver used to convert an AC input into an 8VDC output. It may be operated from a wide range of input voltages and is wet-location listed.



LDR8-40

Specifications

Input Range: 100~240VAC
Frequency Range: 50/60 Hz
Output: 8VDC (Adjustable +10% / -25%)
Max. Output Current: 5.0A
Max. Output Power: 40W
Protection: Overload, Overcurrent, Short Circuit
Operating Temperature: -30°C to +60°C

Mechanical Specifications

Dimensions: 3" x 9.75" x 2"
Weight: 1.94 lbs
Enclosure Rating: Nema 3/IP65
Mounting: Flange Mount
Connection: Knockouts for 1/2" Conduit

LED Capacity

0.10 Watt LEDs: 400 each
0.20 Watt LEDs: 200 each
0.27 Watt LEDs: 148 each
0.40 Watt LEDs: 100 each

Tokistar's LDR8-80 is a dual output Class 2 LED driver with two independent 40 Watt outputs. It may be operated from a wide range of input voltages and is wet-location listed.



LDR8-80

Specifications

Input Range: 100~240VAC
Frequency Range: 50/60 Hz
Output: 8VDC (Adjustable +5% / -30%)
Max. Output Current: 10.0A (2 @ 5.0A)
Max. Output Power: 80W (2 @ 40W)
Protection: Overload, Overcurrent, Short Circuit
Operating Temperature: -30°C to +60°C

Mechanical Specifications

Dimensions: 3.6" x 11" x 2.25"
Weight: 4 lbs
Enclosure Rating: Nema 3/IP65
Mounting: Flange Mount
Connection: Knockouts for 1/2" Conduit

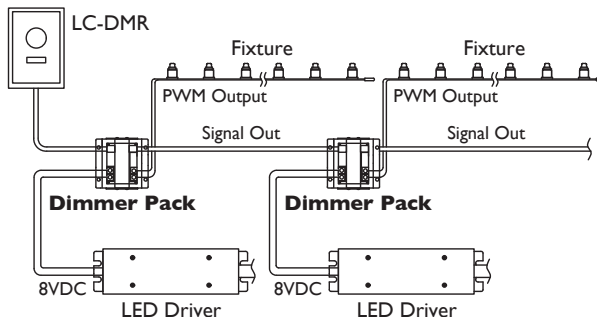
LED Capacity

0.10 Watt LEDs: 800 each
0.20 Watt LEDs: 400 each
0.27 Watt LEDs: 296 each
0.40 Watt LEDs: 200 each

LED Dimmers

LC Dimming System

This proprietary Dimming System provides full-range dimming of Tokileds. The system components connect with CAT5 cable. Up to 25 dimmer packs may be connected in series if the total length of all CAT5 cable does not exceed 165 feet from the wall dimmer to the last dimmer pack. CAT5 cables are included with units.



Part #: LC-DMR

The remote wall dimmer has a rotary dial and on/off switch. Power to the wall dimmer is provided from the LED driver powering the first dimmer pack.



Part #: LC-1CH-DP

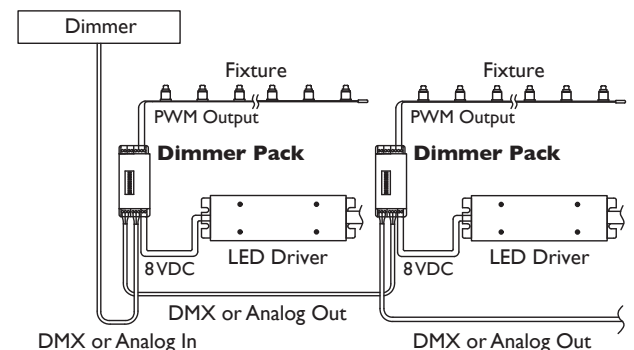
Each dimmer pack receives an 8VDC input from an LED driver and sends a PWM output to the fixture. Logic input and output is communicated through CAT5 cable. Dimensions: 1-1/2" x 3-1/2" x 4-1/16"

LC-1CH-Multi System

Tokistar's LC-1CH-MULTI Dimmer Pack is compatible with industry-standard dimmers working on DMX or 0/1-10VDC protocol. In the manual mode, a preset light level can be set without the use of an external dimmer. In the DMX mode, the dimmer pack is addressable.

Part #: LC-1CH-MULTI

Max. Load: 40 Watts @ 8VDC
Environmental Rating:
Dry Location/IP20
Dimensions: 3/4" x 1-3/4" x 3-1/2"
Weight: 50g / 0.11 lbs
Listing: ETL Listed/CE Certified
Operating Temperature: 0~+50°C



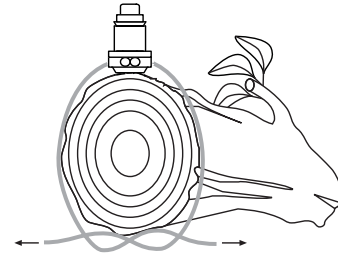
Dual output LED Drivers require a dimmer pack for each output.

Mounting Fixtures

The proper mounting device is determined by the surface the Lightstring is being attached to.

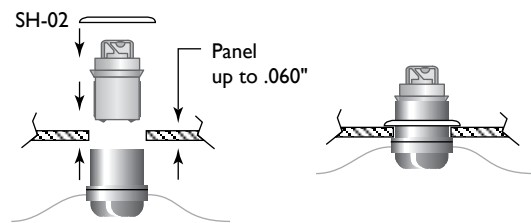
Option 1 - Part#: NSY-TP

Clear elastic nursery tape may be used to secure Lightstrings to branches without inhibiting growth.



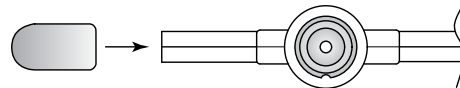
Option 2 - Part#: SH-02 Stainless Steel Fastener

The SH-02 fastener is used to securely attach Lightstring sockets to panels through a 3/8" Ø hole.



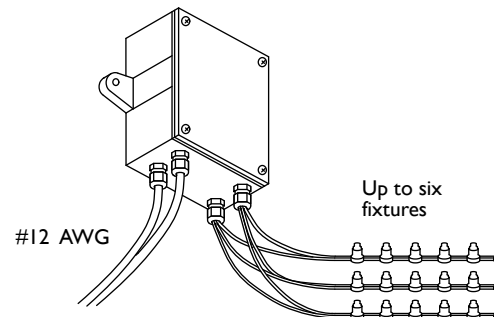
Part#: EC-FL Vinyl End Caps

Lightstrings may be cut to size on site. Vinyl end caps insulate the end of the wire.



Part#: HC-10 Junction Box

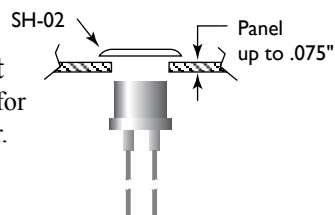
This gasketed junction box accepts #12 AWG Landscape Cable, which may be spliced to 6 independent Lightstring fixtures.



For applications requiring independent points of light, our FL-200 and FL-300 sockets are provided with a 12" lead wire.

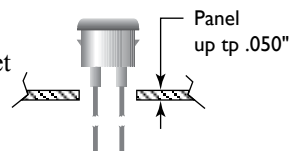
Part#: FL-200 Socket

This is a back-mount socket for use with the SH-02 fastener.
Hole size 3/8"Ø.



Part#: FL-300 Socket

For front-mount applications, this socket remains close to flush to the surface.
Hole size 3/8"Ø.



FIXTURE TYPE F9



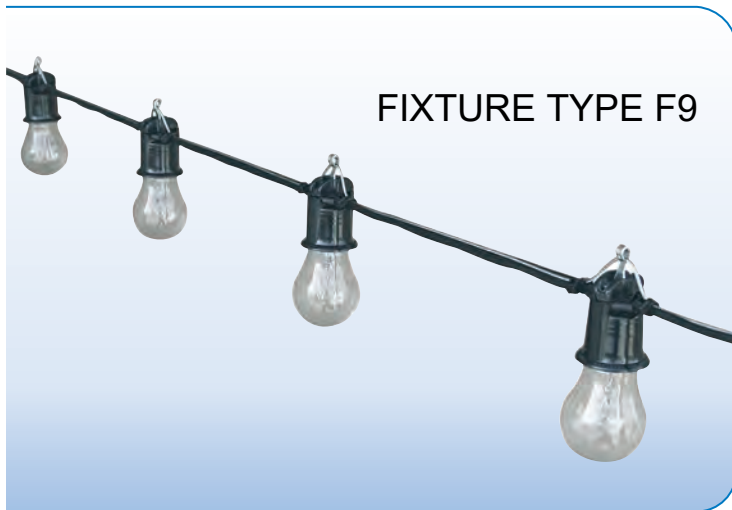
DECOSTRING

LED / INCANDESCENT

SUSPENDED DECORATIVE STRINGLIGHT SYSTEMS

WWW.PRIMUSLIGHTING.COM

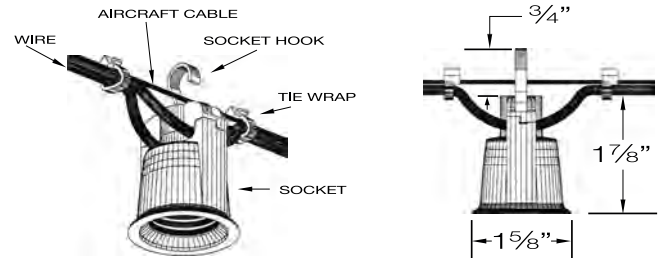
SUSPENDED DECORATIVE STRINGLIGHT SYSTEMS



FIXTURE TYPE F9

PROJECT:

TYPE:



SOCKET, WIRE & CABLE DETAILS

Decostrings are a perfect accent lighting solution to add a personal ambience to patios, courtyards, atriums, restaurants, amusement parks and any open area. The “festoon” lighting system is typically strung between two anchorage points with optional intermediary support and electrically fed from one end. The sockets can be either symmetrically spaced or randomly spaced to suit the application. Optional shades, guards and lenses complete the architectural design.

SPECIFICATIONS

LAMPHOLDER	Black phenolic, medium base UL weatherproof with hook for optional mounting.
WIRE	12/2 G. Black flexible wire rated for 25A max, uv rated for outdoor use and long lasting.
SUPPORT CABLE	1/16" aircraft catenary cable supports the system, 480# test. Heavier cable available. (See Page ?)
LAMPS	LED and incandescent medium base A, G or S style lamps. (See Page 3 for Lamp Options)
ACCESSORIES	Optional brass, aluminum and acrylic shades. (See Page 4 & 5 for Shade Options) Consult factory for custom shades not shown in catalog.
GUIDELINES	Many ways to install and create a design. (See Page 6 & 7)
PHOTOMETRY	Bare lamp and shielded “BUG” rated .IES files available. (See Page 8) (Consult Factory or Visit Website)
CERTIFICATION	ETL listed for dry or wet and permanent installation. 2001431 MADE IN THE USA
VOLTAGE	120V system (1920 watts max load). No driver or transformer required. (Consult Factory for 12V/24V)
DIMMING	Dimmable down to 10% with leading or trailing edge type dimmers.

PART NUMBER

SERIES	SPACING	VOLTS	LAMP	SHADE-FINISH	LENGTH
DSD DECOSTRING DRY	12 12"O/C	120 120V	SELECT FROM LAMP PAGE	<u>OPTIONAL</u>	SPECIFY
DW DECOSTRING WET	18 18"O/C			SELECT SHADE AND FINISH OR LEAVE BLANK	
	24 24"O/C				
	36 36"O/C				
	48 48"O/C				
	(OTHER, SPECIFY)				

LED FILAMENT STYLE LAMPS

FIXTURE TYPE F9



STOCK

PLED-S14F-24K-150
PLED-S14F-27K-150
FROSTED-CONSULT FACTORY
1.5W | 150L



STOCK

PLED-G16.5F-3.5W-24K
PLED-G16.5F-3.5W-27K
3.5W | 325L

PLED-G16.5F-2W-24K
PLED-G16.5F-2W-27K
2W | 200L



A15 & A19
CONSULT FACTORY
SPECIAL ORDER
(SUBJECT TO AVAILABILITY)



S14F VARIOUS COLORS
CONSULT FACTORY (SPECIAL ORDER)
(SUBJECT TO AVAILABILITY)



G25
CONSULT FACTORY
SPECIAL ORDER
(SUBJECT TO AVAILABILITY)

* NOTE: LED LAMPS DIM DOWN TO 10% WITH A TRAILING EDGE (ELV) DIMMER.

INCANDESCENT LAMPS



LE

A15 CLEAR 120V 15W
LF
A15 CLEAR 120V 25W



LS

S14 CLEAR 120V 11W
COLORS AVAILABLE



LH-C

G16.5 CLEAR 120V 25W
LH-W
G16.5 WHITE 120V 25W



LG

S11 CLEAR 120V 7.5W
COLORS AVAILABLE

FULL SPECIFICATION SHEETS AVAILABLE AT PRIMUSLIGHTING.COM.
PHOTOMETRY: BARE LAMP AND SHIELDED "BUG" RATED IES FILES AVAILABLE - CONSULT FACTORY

DSC7 7" W X 3" H CONE SHADE
DSC10 10" W X 3" H CONE SHADE
DSC12 12" W X 4" H CONE SHADE
 FINISH: RAW, ACID ETCHED BRASS OR POWDER COAT



DSH4 4" W X 1 7/8" H HAT SHADE
DSH6 6" W X 2 1/4" H HAT SHADE
DSH8 8" W X 2 3/4" H HAT SHADE
 FINISH: RAW, ACID ETCHED BRASS OR POWDER COAT



DSRW4 4" W X 1 7/8" H RADIAL WAVE SHADE
DSRW6 6" W X 2 1/4" H RADIAL WAVE SHADE
DSRW8 8" W X 2 3/4" H RADIAL WAVE SHADE
 FINISH: RAW, ACID ETCHED BRASS OR POWDER COAT



DST6P 6" W X 8" H PERFORATED TUBE SHADE
 FINISH: RAW, ACID ETCHED BRASS OR POWDER COAT



DST6C 6" W X 8" H WIRE CAGE TUBE
 FINISH: RAW, ACID ETCHED BRASS OR POWDER COAT



DSRG 6" W X 5 1/8" H
 ROUND SHADE WITH GUARD
 FINISH: RAW, ACID ETCHED BRASS OR POWDER COAT



DSWG 3 7/8" W X 5 5/8" H
 WIRE GUARD
 FINISH: CAD PLATED OR POWDER COAT
 CAN BE USED WITH CONE SHADE DSC10, DSC12



DSSLG 3 1/2" W X 4 1/2" H
 ALUMINUM SQUARE LAMP GUARD
 FINISH: POWDER COAT ONLY



DSRLG 5" W X 4" H
METAL ROUND LAMP GUARD
FINISH: POWDER COAT ONLY



DST6A 6" W X 8" H ACRYLIC TUBE SHADE
FINISH: OPAL WHITE, CLEAR OR FROSTED



DSS8 8" DIAMETER ACRYLIC SPHERE

DSS10 10" DIAMETER ACRYLIC SPHERE

DSS12 12" DIAMETER ACRYLIC SPHERE

FINISH: OPAL WHITE, CLEAR OR FROSTED



SHADES & GUARDS FINISH CODES

RAW & ACID ETCHED FINISHES



RB – RAW BRASS



AB – AGED BRASS

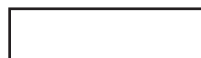


VB – VERDE BRASS



BA – BRUSHED ALUM

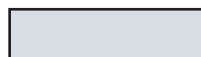
POWDER COAT FINISHES



PCW – POWDER COAT WHITE



PCB – POWDER COAT BLACK

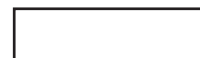


PCS – POWDER COAT SILVER



PCC – POWDER COAT (CUSTOM)
PROVIDE RAL COLOR

ACRYLIC FINISHES



O – OPAL
WHITE



C – CLEAR



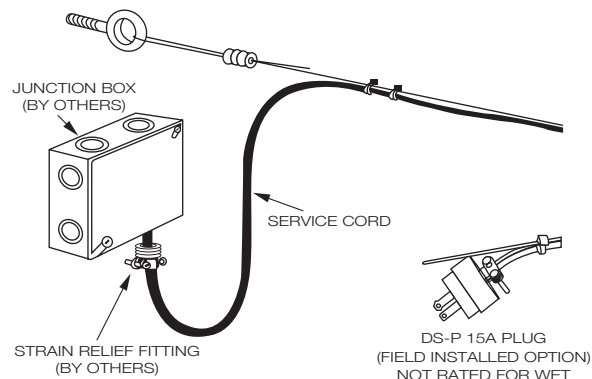
F – FROSTED

SHADES & GUARDS FINISH NOTES

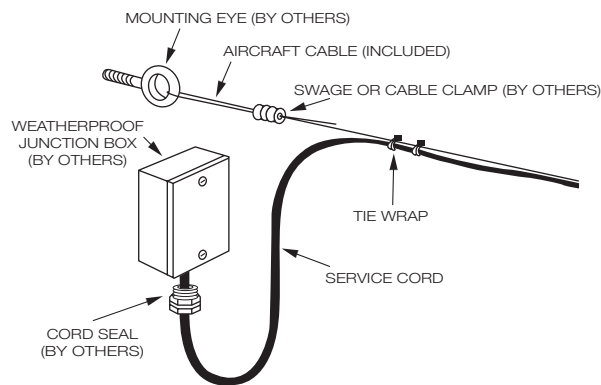
- Decostring shades are hand crafted from solid brass or aluminum and feature either chemical etched or powder coat finishes.
- Most shades are shipped separately and attached to cable system by means of a tool-less keeper ring.
- All shades and guards dimensions are nominal.
- Please contact us for material, finish and shape variations or custom designs.

DECOSTRING MOUNTING

DRY LOCATION MOUNTING



WET LOCATION MOUNTING



Application

Bollard tubes without any additional components form the basic tubes of the BEGA system bollards. Provided with mounting system that allows the luminaire to be adjusted independent of the anchor bolt orientation.

Materials

Bollard tube and base plate constructed of extruded and die-cast marine grade, copper free (≤0.3% copper content) A360.0 aluminum alloy
Cast aluminum wiring box for electrical connections internal to tube
5-conductor cable with quick connect for attachment to BEGA system bollard head
Mechanically captive stainless steel fasteners
Anchorage constructed of galvanized steel

NRTL listed to North American Standards, suitable for wet locations
Weight: 13.0lbs

Finish

All BEGA standard finishes are matte, textured polyester powder coat with minimum 3 mil thickness.

Available colors	Black (BLK)	White (WHT)	RAL:
	Bronze (BRZ)	Silver (SLV)	CUS:

Type:
 BEGA Product:
 Project:
 Modified:

Compatible bollard head (select one)

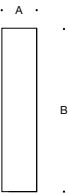
- 84 683 Unshielded with safety guard
- 99 727 Unshielded
- 99 776 Unshielded with safety guard - 180°
- 99 765 Unshielded with safety guard - 360°
- 99 857 Shielded with reflector - 180°
- 99 856 Shielded with reflector - 360°
- 99 862 Shielded
- 99 622 Shielded
- 71 127 Non-illuminated cap

See individual bollard head spec sheet for details.

Available accessories

- 70 896 Direct burial anchorage

See individual accessory spec sheet for details.



System bollard tube · with access door · height 32 1/8

	Door	A	B	Anchorage
99 622	✓	7 1/2	32 1/8	79 818



FIXTURE TYPE F10

BEGA LED system bollard - luminaire head with shielded light - 360°

Enclosure: Housing constructed of die-cast aluminum. Die-castings are marine grade, copper free (≤ 0.3% copper content) A360.0 aluminum alloy. Glass diffuser, inside white. Fully gasketed for weather tight operation using molded silicone gasket.

Installation: BEGA LED system bollards are designed for easy attachment to system bollard tubes using an interlocking stainless steel mechanism and stainless steel set screw threaded into stainless steel insert. An accompanying bollard tube must be selected for proper installation, see below chart for compatible tube options.

Electrical: 16.5W LED luminaire, 19.8 total system watts, -30°C start temperature. Integral 120V through 277V electronic LED driver, 0-10V dimming. LED module(s) are available from factory for easy replacement. Standard LED color temperature is 3000K with a >80 CRI. Available in 4000K (>80 CRI); add suffix K4 to order.

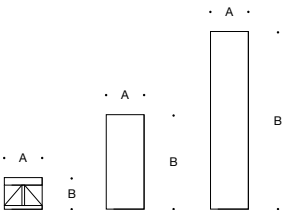
Note: LEDs supplied with luminaire. Due to the dynamic nature of LED technology, LED luminaire data on this sheet is subject to change at the discretion of BEGA-US. For the most current technical data, please refer to www.bega-us.com.

Finish: All BEGA standard finishes are polyester powder coat with minimum 3 mil thickness. Available in four standard BEGA colors: Black (BLK); White (WHT); Bronze (BRZ); Silver (SLV). To specify, add appropriate suffix to catalog number. Custom colors supplied on special order.

CSA certified to U.S. and Canadian standards, suitable for wet locations. Protection class IP65

Weight: 8.4 lbs

Luminaire Lumens: 1286



Bollard heads · shielded · 360°			
	Lamp	A	B
99 862	16.5W LED	7½	5½

Bollard tubes				
	Integrated components	Door	A	B Anch. unit
99 622	—	✓	7½	32 79 818
99 644	1 LED floodlight 19.3W	✓	7½	32 79 818
99 626	GFCI outlet	✓	7½	32 79 818
99 658	Passive infrared motion sensor	✓	7½	32 79 818
99 635	Emergency lighting battery 10W	✓	7½	32 79 818
99 615	—		7½ 14½	79 817

Type:
BEGA Product:
Project:
Voltage:
Color:
Options:
Modified:



Tools Required:

Phillips medium screwdriver
Medium slotted screwdriver
Adjustable wrench

Installation Instructions for BEGA anchorage kits:

79 816, 79 817, 79 818, 79 819, 79 823

Anchorage kit supplied with BEGA fixtures.

FIXTURE TYPE F10

Notice to Installer:

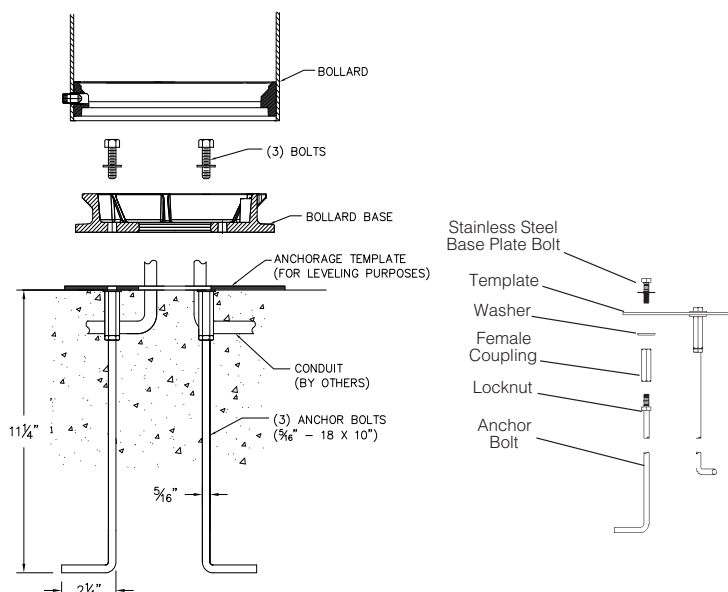
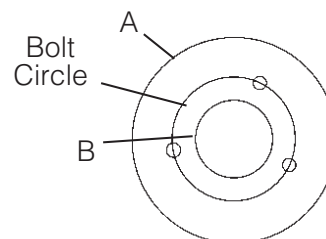
1. Fixture may be damaged if connected to conduit systems that contain water - Article 300-5G of the National Electric Code requires that "Conduits or raceways through which moisture may contact energized live parts shall be sealed or plugged at either or both ends."
2. Anchorage kit must be installed in concrete pad/foundation.
3. It is recommended that when installing in planting areas the bollard base be slightly elevated to avoid prolonged submerging during heavy rains.
4. Wet location listing does not imply suitability for exposure to standing water for long periods of time.

NOTE: Refer to specific bollard installation sheet for proper anchor bolt orientation, if required.

Anchorage installation:

1. Provide means to bring supply wiring to the bollard in accordance with local code. See table for size of template conduit hole for conduit entry.
 2. Assemble anchorage kit. Unscrew the (3) hex bolts from the female couplers. Remove each hex bolt and washer. Align each anchor bolt with the hole in the template. Attach each anchor bolt to the template by replacing the washer and hex bolt and tightening.
 3. Determine the finished grade for the application. Use leveling hardware to adjust template to desired finished height after pouring.
 4. Install anchorage kit using either method:
 - A. Attach template to forming or cross bracing using the (2) nail holes provided in the template. Level template properly. Pour concrete.
 - B. Insert anchorage assembly into poured concrete. Concrete must be vibrated to ensure proper anchorage setting. Level template properly.
 5. Remove (3) hex bolts and washers once anchorage is set.
 6. Remove template. Smooth concrete pad as required.
- NOTE:** Allow adequate time for concrete to cure properly.
7. Remove base plate from bollard by loosening bolt(s) or set screw(s) near bollard base.
 8. Align base plate holes with anchorage holes.
 9. Bolt the base plate to the anchorage kit using the (3) hex bolts and washers.
 10. Make supply wiring connections to wire leads from ballast inside the fixture
MAIN VOLTAGE SUPPLY WIRE TO BLACK BALLAST WIRE;
NEUTRAL (COMMON) SUPPLY WIRE TO WHITE BALLAST WIRE;
GREEN GROUND WIRE TO GREEN BALLAST WIRE.
 11. Place the bollard over the base plate so that the (3) notches in the base plate align with the top. Lock fixture into place by turning bollard 1/4" turn.
 12. Secure the bollard by tightening the bolt(s) or set screw(s) provided.

	Bolt Circle	A	B
79 816:	2 3/4	4 1/4	1
79 817:	3 15/16	6 5/8	2 3/8
79 818:	5 3/16	9 1/8	3
79 819:	5 3/16	9 1/8	3
79 823:	5 3/16	7	2 3/8



STEAMBOAT BASE AREA

PROMENADE AND GOLD WALK



APPENDIX A

Fixture Cuts

Job Number:
DV20131

Issue Description:
BP3: GOLD WALK & PROMENADE

Issue Date:
5/19/2021

LED Fixtures



FEATURES & SPECIFICATIONS

INTENDED USE — The CLX is a linear lighting solution that is available in multiple lengths, lumen packages and distributions. Designed for versatility, the CLX can address virtually any indoor lighting need. The CLX is also offered in standard and high efficacy configurations and capable of being continuous row mounted or installed as a stand-alone fixture. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate. [Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.](#)**

CONSTRUCTION — Channel and cover are formed from code-gauge cold-rolled steel. Housing and lens endcaps are injection molded plastic to provide a more architectural look and feel. The endcaps come standard with a 7/8" knock out for continuous mounting but can be ordered without.

Finish: Paint options include high-gloss, baked white polyester (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). Five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Offered with acrylic lens and less lens configurations. Provides a choice of optical distributions including, wide, narrow, and aisle.

ELECTRICAL — Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications. (See PLR, ordering information on page 14.) Electronic LED driver is multi-volt input and 0-10V dimming standard (see Operational Data on page 12 for actual wattage consumption). This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

L70>100,000 hours at 25°C.

LEDs provide nominal 80 CRI or 90 CRI at 3000 K, 3500 K, 4000 K, or 5000 K.

Lumen output up to 2,500 lumens per foot.

INSTALLATION — Fixture may be ceiling or wall mounted (with or without THCLX hanger or angle mounted with CLXANGBRT), pendant or stem mounted with appropriate mounting options.

WARNING — Removing the lens and opening the fixture during installation exposes the LEDs, putting them at risk for damage.

If you plan to surface mount the fixture, we recommend using the THCLX. This eliminates the need to open the fixture.

If you plan to continuous row mount, we recommend using the PLR wiring harness option. This eliminates the need to open the fixture.

Damage to the LEDs caused during installation will not be covered under the warranty.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -4°F (-20°C) and 104°F (40°C). Optional High Ambient (HA) ranging to 122°F (50°C) available on certain lumen packages (See ambient temperature chart for additional information).

DesignLights Consortium™ (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/DPL to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at:

www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25°C.

Specifications subject to change without notice.

Catalog Number	
Notes	
Type	

LED Linear

CLX

24", 36", 48" and 96" Lengths

Flat Diffuse Lens

Round Diffuse Lens

Wide Diffuse Lens



Stock configurations are offered for shorter lead times:

Stock Part Number	UPC	DLC QPL Product ID	DLC Premium
CLX L48 3000LM SEF FDL MVOLT G210 40K 80CRI WH	00191723525816	PJANKZR4	Yes
CLX L48 3000LM SEF FDL MVOLT G210 50K 80CRI WH	00191723525885	PKW32VKL	Yes
CLX L48 5000LM SEF FDL MVOLT G210 40K 80CRI WH	00191723525939	P77I8Z20	Yes
CLX L48 5000LM SEF FDL MVOLT G210 50K 80CRI WH	00191723525908	P8A42C1H	Yes
CLX L96 6000LM SEF FDL MVOLT G210 40K 80CRI WH	00191723525861	PPFTGRBV	Yes
CLX L96 6000LM SEF FDL MVOLT G210 50K 80CRI WH	00191723525915	PW6250TE	Yes
CLX L96 10000LM SEF FDL MVOLT G210 40K 80CRI WH	00191723525922	PYKOC7EW	Yes
CLX L96 10000LM SEF FDL MVOLT G210 50K 80CRI WH	00191723525830	PKYPL35K	Yes
CLX L48 3000LM SEF RDL MVOLT G210 40K 80CRI WH	00191723525960	PJANKZR4	Yes
CLX L48 3000LM SEF RDL MVOLT G210 50K 80CRI WH	00191723525892	PKW32VKL	Yes
CLX L48 5000LM SEF RDL MVOLT G210 40K 80CRI WH	00191723525854	P77I8Z20	Yes
CLX L48 5000LM SEF RDL MVOLT G210 50K 80CRI WH	00191723525946	P8A42C1H	Yes
CLX L96 6000LM SEF RDL MVOLT G210 40K 80CRI WH	00191723525878	PPFTGRBV	Yes
CLX L96 6000LM SEF RDL MVOLT G210 50K 80CRI WH	00191723525823	PDOSSAD	Yes
CLX L96 10000LM SEF RDL MVOLT G210 40K 80CRI WH	00191723525953	PYKOC7EW	Yes
CLX L96 10000LM SEF RDL MVOLT G210 50K 80CRI WH	00191723525847	PKYPL35K	Yes

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

INDUSTRIAL

CLX
Page 1 of 14

STEAMBOAT BASE AREA PROMENADE AND GOLD WALK

14143 Denver West Pkwy, Suite 300 Golden, CO 80401 PH:(303)421.6655

www.me-engineers.com

Issue: **BP3: GOLD WALK & PRO**

Date: **19-May-21**

Project #: DV20131

Type: L1,L6,L6A

CLX LED Linear

ORDERING INFORMATION		Lead times will vary depending on options selected. Consult with your sales representative.				Example: CLX L48 5000LM SEF WDL MVOLT GZ10 40K 80CRI WH					
Series	Length	Nominal lumens		Performance package		Louver		Lens			
CLX LED linear	L24 24" ^{1,2}	1500LM	1,500 lumens	SEF	Standard efficiency ¹	(Blank)	Less louver	L/Lens	Less lens		
		2000LM	2,000 lumens	HEF	Premium efficiency	SBLW	Straight blade louver, white ⁶	FDL	Flat diffuse ^{7,8}		
		2500LM	2,500 lumens			SBLMB	Straight blade louver, matte black ⁶	RDL	Round diffuse ^{7,8}		
		3500LM	3,500 lumens			SBLGV	Straight blade louver, galvanized ⁶	WDL	Wide diffuse ^{7,8}		
		4500LM	4,500 lumens			SBLSKG	Straight blade louver, smoke gray ⁶				
	L36 36" ²	2250LM	2,250 lumens								
		3000LM	3,000 lumens								
		3750LM	3,750 lumens								
		5250LM	5,250 lumens								
		6750LM	6,750 lumens								
	L48 48"	3000LM	3,000 lumens								
		4000LM	4,000 lumens								
		5000LM	5,000 lumens								
		7000LM	7,000 lumens ¹								
		9000LM	9,000 lumens ²								
	L96 96"	10000LM	10,000 lumens ^{3,4}								
		6000LM	6,000 lumens								
		8000LM	8,000 lumens								
		10000LM	10,000 lumens								
		14000LM	14,000 lumens ^{2,4}								
L180 180"	18000LM	18,000 lumens ^{2,4}									
	20000LM	20,000 lumens ^{2,4}									
Distribution		Voltage		Driver ¹⁴		Color temperature		Coloring rendering index			
(Blank) General		MVOLT	120-277V ¹⁰	277	277V	GZ10	0-10V dimming ¹⁵	30K	3000 K	80CRI	80 CRI
ND Narrow ^{4,9}		120	120V	347	347V ^{12,13}	EZ1	Dimming to 1% ²	35K	3500 K	90CRI	90 CRI
WD Wide ^{4,9}		208	208V ¹¹	480	480V ^{12,13}			40K	4000 K		
AD2 Aisle, 24" off center ^{4,9}		240	240V ¹¹					50K	5000 K		
Options										Finish	
PS1050	Emergency battery pack, 10W, CA Title 20 Noncompliant ^{2,11,13,16,17}	PLR	Plug-in wiring, see page 16 for ordering information	nLight [®] Wired ^{21,25}		WH	White				
E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS ^{2,11,13,16,17}	PLR1LVG	Plug-in wiring, low voltage dimming ¹²	N100	nLight [®] without lumen management	GALVW	Galvanized with white lens end caps				
BGTD	Generator transfer device, not available with PS1050 ^{13,16,18}	RRL	RELOC [®] -ready luminaire. See page 15 for ordering information	NES7	nLight [®] nES 7 PIR integral occupancy sensor ²⁶	GALVB	Galvanized with black lens end caps				
OCS	5', 18/3 Reloc selectable One Pass cable ¹⁶	SPD	Surge protection device, provides up to 6kV protection ²⁰	NESPD7	nLight [®] nES PDT 7 dual technology integral occupancy control ²⁴						
HA	High ambient, for use in ambient temperatures up to 50°C ¹¹	USPOM	Assembled in the United States	NES7ADCX	nLight [®] nES 7 ADCX PIR integral occupancy sensor with automatic dimming photocell ²⁴	MB	Matte black				
EPNKO	Decorative endplate, no knock out ¹⁹			NESPD7ADCX	nLight [®] nES PDT 7 dual technology integral occupancy sensor with automatic dimming photocell ²⁶	SKGYW	Smoke gray with white lens end caps				
OUTCTR	Wiring leads pulled through back center of fixture ²⁰	nLight [®] Wireless ^{21,24}				SKGYB	Smoke gray with black lens end caps				
OUTEND	Wiring leads pulled through end of fixture ²¹	NLTAIR2 RES7	nLight [®] Generation 2 enabled PIR integral occupancy sensor with automatic dimming photocell								
Cord Sets:		NLTAIR2 RES7PDT	nLight [®] AIR Generation 2 enabled dual technology integral occupancy sensor with automatic dimming photocell								
CS1W	Straight blade plug, 120V ^{10,16}	NLTAIR2 RIO	No sensor control								
CS3W	NEMA twist-lock plug, 120V ^{10,16}										
CS7W	Straight blade plug, 277V ^{10,16}										
CS11W	NEMA twist-lock plug, 277V ^{10,16}										
CS25W	NEMA twist-lock plug, 347V ^{10,16}										
CS97W	NEMA twist-lock plug, 480V ^{10,16}										
CS93W	600V SEOOV white cord, no plug (no voltage required)										
CS6WG16STOWDSD	6' white cord, 16/5, no plug, includes low voltage dimming wires (no voltage required) ¹⁵										

See Accessories and footnotes on next page



CLX

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-315-4963 www.lithonia.com

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STEAMBOAT BASE AREA

PROMENADE AND GOLD WALK

14143 Denver West Pkwy, Suite 300 Golden, CO 80401 PH:(303)421.6655

www.me-engineers.comIssue: **BP3: GOLD WALK & PRO**Date: **19-May-21**

Project #: DV20131

Type: L1,L6,L6A

CLX LED Linear

Accessories: Order as separate catalog number.					
Mounting:		THCLX ____	Tong hanger (Must specify color) (one pair) ²⁸	CLXRWU24 ____	Wide decorative 24" reflector with uplight, (Must specify color) ³⁰
ZACVH M100	Adjustable 10' aircraft cable with Y hanger (1 pair)	CLXANGBKT ____	Angle bracket, (Must specify color) (one pair) ¹⁸	CLXRWU36 ____	Wide decorative 36" reflector with uplight, (Must specify color) ³⁰
ZAC120	One adjustable aircraft cable with canopy 120" ²⁷	HC39 M12	Hanger chain, 36" (1 pair)	CLXRWU48 ____	Wide decorative 48" reflector with uplight, (Must specify color) ³²
		Sensors & Controls:		CLXRWU96 ____	Two wide decorative 48" reflectors with uplight, (Must specify color) ³⁰
ZACFP120	One adjustable aircraft cable with feed (3 conductor) and canopy, 120" ²⁷	LSXR	Sensor Switch * LSXR occupancy sensor ²⁹	CLXRN24 ____	Narrow 24" reflector, (Must specify color) ³¹
ZACFPD120	One adjustable aircraft cable with feed (5 conductor) and canopy 120" ²⁷	NPP16D	nLight® switching/dimming module	CLXRN36 ____	Narrow 36" reflector, (Must specify color) ³¹
ZAC240	One adjustable aircraft cable with canopy 240" ²⁷	NPP16DER	nLight® switching/dimming module with emergency relay	CLXRN48 ____	Narrow 48" reflector, (Must specify color) ³¹
ZACFP240	One adjustable aircraft cable with feed (3 conductor) and canopy, 240" ²⁷	rPP20D	nLight™ air dimming/switching module	CLXRN96 ____	Two narrow 48" reflectors, (Must specify color) ³¹
ZACFPD240	One adjustable aircraft cable with feed (5 conductor) and canopy 240" ²⁷	XPA CMRB0	XPoint™ Wireless 0-10V relay, external, 55°C max ambient	Wireguards:	
SQ ____	Swivel stem hanger (specify length in 2" increments up to 48") ²⁷	Reflectors:		WGCLX24 ____	24" wireguard, (Must specify color) ³²
		CLXRW24 ____	Wide decorative 24" reflector, (Must specify color) ³⁰	WGCLX36 ____	36" wireguard, (Must specify color) ³²
		CLXRW36 ____	Wide decorative 36" reflector, (Must specify color) ³⁰	WGCLX48 ____	48" wireguard, XX, (Must specify color) 96" fixture requires two ³²
		CLXRW48 ____	Wide decorative 48" reflector, (Must specify color) ³⁰		
		CLXRW96 ____	Two wide decorative 48" reflectors, (Must specify color) ³⁰		

Notes

- Not available with OUTCTR option.
- Not available with HA option.
- Not available with SEF when ordered in combination with EZ1.
- Not available with NLTAIR2 RES7, NLTAIR2 RES7PD1, or NLTAIR2 RIO.
- Not available with EZ1 when ordered with L24 with 5000LM or L36 with 7500LM.
- When ordered with L24 only available with 1500LM or 2000LM in combination with GZ10 driver. Not for use with THCLX, CLXANGBKT, CLX reflectors or WGCLX accessories. Not available with RDL lens options.
- Only available with general distribution.
- Not available with CLXRN accessories.
- Available L/LENS only.
- Not available with PS1050, E10WLCP, or BGTD.
- Not available with BGTD option.
- Voltage selected utilizes a step-down transformer. Not available with L24 when ordered with N100. Not available with PS1050, E10WLCP or BGTD option.
- Requires SPD option.
- When continuous row mounting, fixtures must all have the same driver selection.
- Not available with individual controls, nLight wired networking, nLight wireless networking, nLight wireless zone control options.
- Must specify voltage.
- Not available with L24 or L36. Not available with L48 in combination with N100.
- Available with L48 or L96 only. 20 Not available with PS1050 or E10WLCP options. Not available with 208 or 240V. Not available Individual controls, nLight Wired, or nLight Wireless options.
- Not available OUTEND.
- Required with PS1050, E10WLCP, BGTD, XAD, or XAD924.
- Not available with PLR options.
- Not available with XPoint, Individual controls, nLight Wired, or nLight Wireless options.
- Sensor housing will be the same color as lens end caps.
- Not available with L24 in combination with 5000LM, not available with L36 in combination with 7500LM, not available with L48 in combination with 10000LM, and not available with L96 in combination with 14000LM, 18000LM, or 20000LM. Not available with PLRs containing low voltage dimming wires.
- Not available with any other control option. Requires EZ1.
- Requires N100 option.
- Ships standard as white.
- Not available with louver, wireguards, wide reflectors.
- More configurations on [LSXR Specification Sheet](#).
- L24 reflector is 22.65", L36 reflector is 34.01", L48 reflector is 46.80", L96 comes with two L48 reflectors.
- For use with L/LENS fixtures only. L24 reflector is 22.75", L36 reflector is 34.20", L48 reflector is 46.85", L96 comes with two L48 reflectors.
- Not for use with CLX wide reflector accessories.

OPTIONS AND ACCESSORIES



Narrow reflector
Ships separately from fixture.
Order as:
CLXRN24 ____
CLXRN36 ____
CLXRN48 ____
CLXRN96 ____



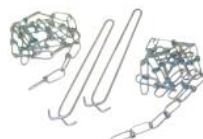
Wide decorative reflector
Ships separately from fixture.
Order as:
CLXRW24 ____
CLXRW36 ____
CLXRW48 ____
CLXRW96 ____



Wireguard
Ships separately from fixture:
96" fixture requires two WGCLX48.
Order as:
WGCLX24 ____
WGCLX36 ____
WGCLX48 ____



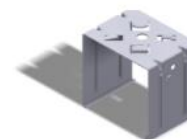
Aircraft Cable with Canopy
Available in 120" or 240"
Order as:
ZAC120
ZAC240



HANGER CHAIN
36" chain with Y hanger, ships as a pair
Order as:
HC36



ZACVH HANGER
10' Aircraft cable with Y hanger.
Order as:
ZACVH



Tong hanger
Ships as a pair
Order As:
THCLX ____



CLX

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-315-4963 www.lithonia.com

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STEAMBOAT BASE AREA

PROMENADE AND GOLD WALK

14143 Denver West Pkwy, Suite 300 Golden, CO 80401 PH:(303)421.6655

www.me-engineers.com

Issue: **BP3: GOLD WALK & PRO**
Date: **19-May-21**
Project #: DV20131

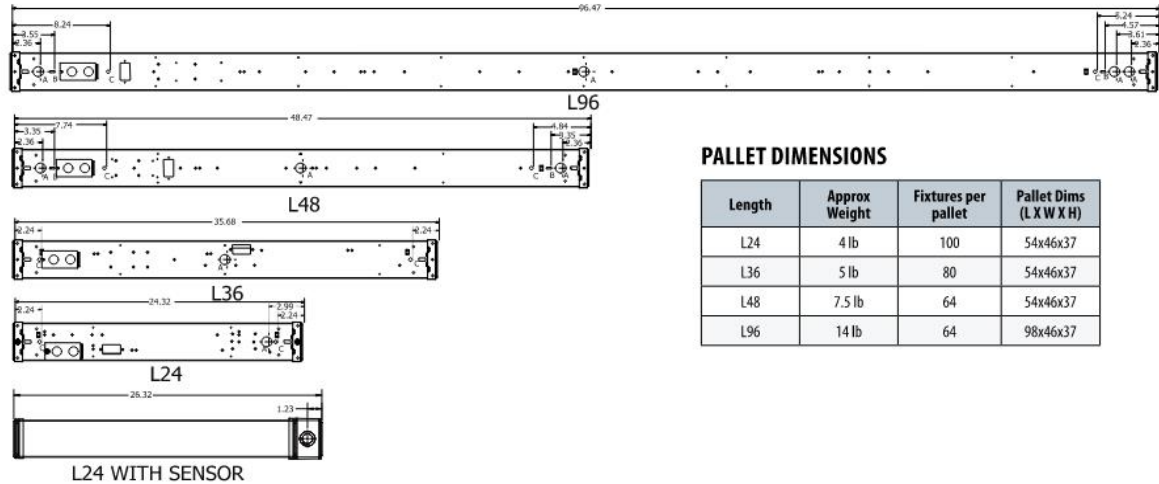
Type: L1,L6,L6A

CLX LED Linear**DIMENSIONS**

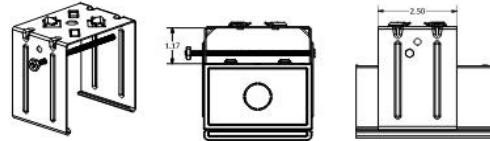
All dimensions are in inches (centimeters) unless otherwise indicated.
Dimensions may vary with options or accessories.

INTEGRATED SENSOR ADDS 2.0 INCHES TO STANDALONE FIXTURE LENGTH
HOUSING END CAP ADDS 0.236 INCHES TO FIXTURE LENGTH PER SIDE. DIMENSIONS BELOW INCLUDE ENDCAPS.

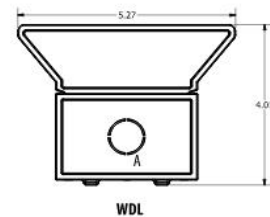
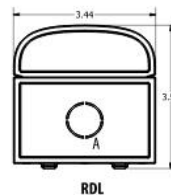
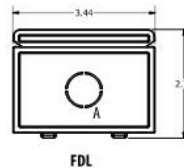
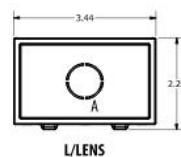
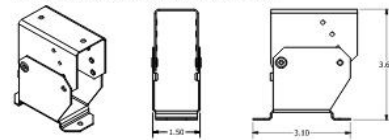
A - 7/8" KNOCK OUT
B - 0.5" by 0.16" SLOT
C - 0.3" DIA HOLE



THCLX - SHIPS TWO PER ORDER.
UTILIZES A #8 HEX HEAD SCREW AND NUT
FIXTURE SITS 1.3 INCHES FROM STRUCTURE WHEN MOUNTED



CLXANGBKT - SHIPS TWO PER ORDER
HOLES TO MOUNTING STRUCTURE ARE 0.175" DIA, 2.5" APART
FIXTURE SITS APPROXIMATELY 3.5" FROM STRUCTURE
WHEN MOUNTED HORIZONTAL TO STRUCTURE

**PHOTOMETRICS**

See www.lithonia.com.



CLX

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CLX LED Linear**POWER SENTRY EMERGENCY BATTERY PACKS**

		SEF Emergency Lumens	HEF Emergency Lumens
PS1050	Factory installable	1400	1500
E10WLCP	Factory installable	1400	1500
PS155SLCP	Field installable, remote mount only	2000	2100

Note: For emergency lumen output of specific model, please consult factory. One board will be illuminated during emergency operation.

CLX CHARACTERISTICS

Nominal Lumen Package	Length	Wattage								Length	Width	Depth	Comparable Light Source
		Standard efficiency				High efficiency							
		120V	277V	347V	480V	120V	277V	347V	480V				
2500LM	24"	19.9	19.9	25.9	25.9	18.5	18.5	24.5	24.5	24	3.5	3.75	1-lamp 32WT8, 1-lamp 54W T5HO, 50W HID
5000LM	24"	41.9	41.9	47.9	47.9	37.9	37.9	43.9	43.9	24	3.5	3.75	2-lamp 32WT8, 1-lamp 54W T5HO, 70W HID
3750LM	36"	28.1	28.1	34.1	34.1	27.0	27.0	33.0	33.0	36	3.5	3.75	1-lamp 32WT8, 1-lamp 54W T5HO, 50W HID
7500LM	36"	62.9	62.9	68.9	68.9	56.8	56.8	62.8	62.8	36	3.5	3.75	2-lamp 32WT8, 1-lamp 54W T5HO, 70W HID
5000LM	48"	35.4	35.4	41.4	41.4	32.9	32.9	38.9	38.9	48	3.5	3.75	2-lamp 32WT8, 1-lamp 54W T5HO, 70W HID
10000LM	48"	77.1	77.1	83.1	83.1	70.4	70.4	76.4	76.4	48	3.5	3.75	3-lamp 32WT8, 2-lamp 54W T5HO, 100W HID
10000LM	96"	70.8	70.8	76.8	76.8	65.8	65.8	71.8	71.8	96	3.5	3.75	3-lamp 32WT8, 2-lamp 54W T5HO, 100W HID
20000LM	96"	154.2	154.2	160.2	160.2	140.8	140.8	146.8	146.8	96	3.5	3.75	6-lamp 32WT8, 4-lamp 54T5HO, 200W HID

AMBIENT TEMPERATURE RATINGS

Driver Package		GZ10			EZ1			Any Driver	
Length	Lumen package	Direct Surface	THCLX/ Suspended	HA Option (Direct or Suspended)	Direct Surface	THCLX	Suspended 18"	Xpoint/ BGTD Direct Surface	PS1050 Suspended
L24	1500LM	40C°	40C°	N/A	35C°	35C°	35C°	N/A	N/A
	2000LM	40C°	40C°		35C°	35C°	35C°		
	2500LM	40C°	40C°		35C°	35C°	35C°		
	3500LM	40C°	40C°		40C°	40C°	40C°		
	4500LM	40C°	40C°		35C°	35C°	40C°		
	5000LM	40C°	40C°		25C°	30C°	35C°		
L36	2250LM	40C°	40C°		40C°	40C°	40C°		
	3000LM	40C°	40C°		40C°	40C°	40C°		
	3750LM	40C°	40C°		40C°	40C°	40C°		
	5250LM	40C°	40C°		35C°	35C°	40C°		
	6750LM	30C°	40C°		35C°	35C°	40C°		
	7500LM	30C°	40C°		25C°	30C°	35C°		
L48	3000LM	40C°	40C°	50C°	40C°	40C°	40C°	35C°	25C°
	4000LM	40C°	40C°	50C°	40C°	40C°	40C°		
	5000LM	40C°	40C°	50C°	35C°	35C°	40C°		
	7000LM	30C°	40C°	N/A	35C°	35C°	40C°		
	9000LM	30C°	40C°		25C°	30C°	35C°		
	10000LM	30C°	40C°		25C°	30C°	35C°		
L96	6000LM	40C°	40C°	50C°	35C°	35C°	40C°		
	8000LM	30C°	40C°	50C°	35C°	35C°	40C°		
	10000LM	30C°	40C°	50C°	25C°	30C°	35C°		
	14000LM	40C°	40C°	N/A	35C°	35C°	40C°		
	18000LM	30C°	40C°		25C°	30C°	35C°		
	20000LM	30C°	40C°		25C°	30C°	35C°		



CLX

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STEAMBOAT BASE AREA

PROMENADE AND GOLD WALK

14143 Denver West Pkwy, Suite 300 Golden, CO 80401 PH:(303)421.6655

www.me-engineers.com

Issue: **BP3: GOLD WALK & PRO**
 Date: **19-May-21**
 Project #: DV20131

Type: L1,L6,L6A

CLX LED Linear**CLX OPERATIONAL DATA**

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
L/Lens	L24	1500LM	SEF	80	1497	1540	1582	1619	10.85
				90	1305	1333	1371	1441	10.85
			HEF	80	1493	1514	1582	1586	10.39
				90	1220	1237	1301	1301	10.39
		2000LM	SEF	80	2066	2125	2183	2235	14.48
				90	1801	1840	1892	1989	14.48
			HEF	80	2060	2089	2183	2189	13.46
				90	1684	1708	1796	1796	13.46
		2500LM	SEF	80	2616	2689	2763	2829	18.41
				90	2279	2329	2394	2517	18.41
			HEF	80	2607	2644	2763	2771	17.42
				90	2132	2161	2273	2273	17.42
		3500LM	SEF	80	3518	3617	3716	3804	25.83
				90	3065	3132	3220	3385	25.83
			HEF	80	3506	3556	3716	3726	25.04
				90	2867	2907	3057	3057	25.04
		4500LM	SEF	80	5040	5182	5325	5451	38.7
				90	4392	4487	4614	4851	38.7
			HEF	80	5024	5096	5325	5339	34.8
				90	4108	4165	4380	4380	34.8
		5000LM	SEF	80	5355	5506	5657	5791	41.48
				90	4667	4767	4902	5153	41.48
			HEF	80	5338	5414	5657	5672	38.11
				90	4364	4425	4653	4653	38.11
	L36	2250LM	SEF	80	2411	2547	2101	2207	16.36
				90	2479	2607	2146	2320	16.36
			HEF	80	2437	2554	1965	2095	15.47
				90	2547	2403	1992	2095	15.47
		3000LM	SEF	80	3221	3388	2730	2868	20.8
				90	3310	3133	2789	3015	20.8
			HEF	80	3167	3319	2553	2722	19.98
				90	3310	3123	2589	2722	19.98
		3750LM	SEF	80	4123	4337	3495	3671	26.47
				90	4236	4010	3570	3859	26.47
			HEF	80	4054	4248	3268	3485	25.09
				90	4236	3997	3314	3485	25.09
		5250LM	SEF	80	5545	5833	4700	4937	39.9
				90	5698	5393	4801	5190	39.9
			HEF	80	5452	5713	4396	4687	34.3
				90	5698	5376	4457	4687	34.3
		6750LM	SEF	80	7081	7448	6001	6303	54.85
				90	7275	6886	6131	6627	54.85
			HEF	80	6962	7294	5613	5984	47.97
				90	7275	6864	5691	5984	47.97
		7500LM	SEF	80	7756	8158	6574	6905	62.6
				90	7969	7543	6716	7260	62.6
			HEF	80	7626	7991	6148	6555	54.02
				90	7969	7519	6234	6555	54.02



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STEAMBOAT BASE AREA

PROMENADE AND GOLD WALK

14143 Denver West Pkwy, Suite 300 Golden, CO 80401 PH:(303)421.6655

www.me-engineers.com

Issue: **BP3: GOLD WALK & PRO**
 Date: **19-May-21**
 Project #: DV20131

Type: L1,L6,L6A

CLX LED Linear**CLX OPERATIONAL DATA (continued)**

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
L/Lens	L48	3000LM	SEF	80	3019	3104	3190	3265	20.32
				90	2631	2688	2764	2906	20.32
			HEF	80	3010	3052	3190	3198	19.01
				90	2461	2495	2624	2624	19.01
		4000LM	SEF	80	4034	4148	4262	4363	27.58
				90	3515	3591	3693	3882	27.58
			HEF	80	4021	4078	4262	4273	24.75
				90	3288	3334	3505	3505	24.75
		5000LM	SEF	80	5047	5189	5332	5458	34.8
				90	4398	4493	4620	4857	34.8
			HEF	80	5031	5102	5332	5346	31.77
				90	4113	4171	4386	4386	31.77
		7000LM	SEF	80	7311	7517	7724	7907	49.05
				90	6371	6509	6692	7036	49.05
			HEF	80	7288	7391	7724	7744	44.67
				90	5959	6042	6353	6353	44.67
		9000LM	SEF	80	9215	9475	9735	9967	63.99
				90	8031	8204	8435	8869	63.99
			HEF	80	9186	9317	9735	9762	58.58
				90	7511	7615	8008	8008	58.58
		10000LM	SEF	80	10299	10590	10880	11139	73.37
				90	8975	9169	9427	9912	73.37
			HEF	80	10266	10412	10880	10910	66.27
				90	8394	8511	8950	8950	66.27
	L96	6000LM	SEF	80	5942	6110	6278	6427	38.15
				90	5178	5290	5439	5719	38.15
			HEF	80	5923	6008	6278	6294	35.54
				90	4843	4911	5164	5164	35.54
		8000LM	SEF	80	7929	8153	8376	8575	52.32
				90	6910	7059	7258	7631	52.32
			HEF	80	7903	8016	8376	8399	48.5
				90	6462	6552	6890	6890	48.5
		10000LM	SEF	80	9808	10085	10362	10608	66.47
				90	8548	8732	8978	9439	66.47
			HEF	80	9777	9916	10362	10390	60.89
				90	7994	8106	8523	8523	60.89
		14000LM	SEF	80	14323	14727	15131	15491	94.78
				90	12482	12752	13111	13784	94.78
			HEF	80	14277	14480	15131	15172	85.96
				90	11674	11836	12447	12447	85.96
		18000LM	SEF	80	18458	18979	19500	19963	128.98
				90	16086	16433	16896	17764	128.98
			HEF	80	18399	18661	19500	19552	116.92
				90	15044	15254	16040	16040	116.92
		20000LM	SEF	80	20386	20962	21537	22048	146.83
				90	17766	18150	18661	19619	146.83
			HEF	80	20321	20610	21537	21595	131.6
				90	16616	16847	17716	17716	131.6



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STEAMBOAT BASE AREA

PROMENADE AND GOLD WALK

14143 Denver West Pkwy, Suite 300 Golden, CO 80401 PH:(303)421.6655

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Issue: **BP3: GOLD WALK & PRO**
 Date: **19-May-21**
 Project #: DV20131

Type: L1,L6,L6A

CLX LED Linear**CLX OPERATIONAL DATA (continued)**

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
RDL	L24	1500LM	SEF	80	1359	1397	1436	1470	10.85
				90	1184	1210	1244	1308	10.85
			HEF	80	1355	1374	1436	1439	10.39
				90	1107	1123	1181	1181	10.39
		2000LM	SEF	80	1875	1928	1981	2028	14.48
				90	1634	1670	1717	1805	14.48
			HEF	80	1869	1896	1981	1987	13.46
				90	1528	1550	1630	1630	13.46
		2500LM	SEF	80	2374	2441	2508	2567	18.41
				90	2069	2113	2173	2284	18.41
			HEF	80	2366	2400	2508	2514	17.42
				90	1935	1962	2063	2063	17.42
		3500LM	SEF	80	3192	3282	3372	3452	25.83
				90	2782	2842	2922	3072	25.83
			HEF	80	3182	3227	3372	3381	25.04
				90	2602	2638	2774	2774	25.04
		4500LM	SEF	80	4574	4703	4832	4947	38.7
				90	3986	4072	4187	4402	38.7
			HEF	80	4560	4624	4832	4845	34.8
				90	3728	3780	3975	3975	34.8
		5000LM	SEF	80	4860	4997	5134	5256	41.48
				90	4235	4327	4448	4677	41.48
			HEF	80	4844	4913	5134	5148	38.11
				90	3961	4016	4223	4223	38.11
	L36	2250LM	SEF	80	2188	2250	2311	2366	16.36
				90	1907	1948	2003	2106	16.36
			HEF	80	2181	2212	2311	2318	15.47
				90	1783	1808	1901	1901	15.47
		3000LM	SEF	80	2843	2924	3004	3075	20.8
				90	2478	2531	2603	2736	20.8
			HEF	80	2834	2875	3004	3012	19.98
				90	2317	2350	2471	2471	19.98
		3750LM	SEF	80	3639	3742	3845	3936	26.47
				90	3171	3240	3331	3502	26.47
			HEF	80	3628	3679	3845	3855	25.09
				90	2966	3007	3162	3162	25.09
		5250LM	SEF	80	4895	5033	5171	5294	39.9
				90	4265	4357	4480	4710	39.9
			HEF	80	4879	4948	5171	5185	34.3
				90	3989	4045	4253	4253	34.3
		6750LM	SEF	80	6250	6426	6602	6759	54.85
				90	5446	5564	5721	6014	54.85
			HEF	80	6230	6318	6602	6620	47.97
				90	5094	5165	5431	5431	47.97
		7500LM	SEF	80	6846	7039	7232	7404	62.6
				90	5966	6095	6266	6588	62.6
			HEF	80	6824	6921	7232	7252	54.02
				90	5580	5657	5949	5949	54.02



CLX

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STEAMBOAT BASE AREA

PROMENADE AND GOLD WALK

14143 Denver West Pkwy, Suite 300 Golden, CO 80401 PH:(303)421.6655

www.me-engineers.com

Issue: **BP3: GOLD WALK & PRO**
 Date: **19-May-21**
 Project #: DV20131

Type: L1,L6,L6A

CLX LED Linear**CLX OPERATIONAL DATA (continued)**

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
RDL	L48	3000LM	SEF	80	2740	2817	2895	2963	20.32
				90	2388	2439	2508	2637	20.32
			HEF	80	2731	2770	2895	2902	19.01
				90	2233	2264	2381	2381	19.01
		4000LM	SEF	80	3661	3764	3868	3959	27.58
				90	3190	3259	3351	3523	27.58
			HEF	80	3649	3701	3868	3878	24.75
				90	2984	3025	3181	3181	24.75
		5000LM	SEF	80	4580	4710	4839	4954	34.8
				90	3992	4078	4193	4408	34.8
			HEF	80	4566	4631	4839	4852	31.77
				90	3733	3785	3980	3980	31.77
		7000LM	SEF	80	6635	6822	7009	7176	49.05
				90	5782	5907	6073	6385	49.05
			HEF	80	6614	6708	7009	7028	44.67
				90	5408	5483	5766	5766	44.67
		9000LM	SEF	80	8363	8599	8835	9045	63.99
				90	7288	7446	7655	8049	63.99
			HEF	80	8336	8455	8835	8859	58.58
				90	6816	6911	7268	7268	58.58
		10000LM	SEF	80	9347	9611	9874	10109	73.37
				90	8145	8321	8556	8995	73.37
			HEF	80	9317	9450	9874	9901	66.27
				90	7618	7724	8122	8122	66.27
	L96	6000LM	SEF	80	5393	5545	5697	5832	38.15
				90	4700	4801	4936	5190	38.15
			HEF	80	5375	5452	5697	5712	35.54
				90	4395	4457	4686	4686	35.54
		8000LM	SEF	80	7196	7399	7602	7782	52.32
				90	6271	6406	6587	6925	52.32
			HEF	80	7173	7275	7602	7622	48.5
				90	5865	5946	6253	6253	48.5
		10000LM	SEF	80	8902	9153	9404	9627	66.47
				90	7757	7925	8148	8567	66.47
			HEF	80	8873	8999	9404	9429	60.89
				90	7255	7356	7735	7735	60.89
		14000LM	SEF	80	12999	13366	13732	14058	94.78
				90	11328	11573	11899	12510	94.78
			HEF	80	12957	13142	13732	13769	85.96
				90	10594	10742	11296	11296	85.96
		18000LM	SEF	80	16751	17224	17697	18117	128.98
				90	14598	14913	15334	16121	128.98
			HEF	80	16698	16936	17697	17744	116.92
				90	13653	13843	14557	14557	116.92
		20000LM	SEF	80	18501	19023	19545	20009	146.83
				90	16123	16471	16935	17805	146.83
			HEF	80	18442	18705	19545	19598	131.6
				90	15079	15290	16078	16078	131.6



CLX

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STEAMBOAT BASE AREA

PROMENADE AND GOLD WALK

14143 Denver West Pkwy, Suite 300 Golden, CO 80401 PH:(303)421.6655

www.me-engineers.com

Issue: **BP3: GOLD WALK & PRO**
 Date: **19-May-21**
 Project #: DV20131

Type: L1,L6,L6A

CLX LED Linear**CLX OPERATIONAL DATA (continued)**

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
FDL	L24	1500LM	SEF	80	1320	1358	1395	1428	10.85
				90	1151	1175	1208	1271	10.85
			HEF	80	1316	1335	1395	1399	10.39
				90	1076	1091	1147	1147	10.39
		2000LM	SEF	80	1822	1874	1925	1971	14.48
				90	1588	1622	1668	1754	14.48
			HEF	80	1816	1842	1925	1930	13.46
				90	1485	1506	1583	1583	13.46
		2500LM	SEF	80	2306	2371	2436	2494	18.41
				90	2010	2053	2111	2219	18.41
			HEF	80	2299	2332	2436	2443	17.42
				90	1880	1906	2004	2004	17.42
		3500LM	SEF	80	3102	3189	3277	3354	25.83
				90	2703	2761	2839	2985	25.83
			HEF	80	3092	3136	3277	3285	25.04
				90	2528	2563	2695	2695	25.04
		4500LM	SEF	80	4444	4570	4695	4807	38.7
				90	3873	3957	4068	4277	38.7
			HEF	80	4430	4493	4695	4708	34.8
				90	3622	3673	3862	3862	34.8
		5000LM	SEF	80	4722	4855	4988	5107	41.48
				90	4115	4204	4322	4544	41.48
			HEF	80	4707	4774	4988	5002	38.11
				90	3848	3902	4103	4103	38.11
	L36	2250LM	SEF	80	2126	2186	2246	2299	16.36
				90	1852	1892	1946	2046	16.36
			HEF	80	2119	2149	2246	2252	15.47
				90	1732	1757	1847	1847	15.47
		3000LM	SEF	80	2762	2840	2918	2988	20.8
				90	2407	2459	2529	2659	20.8
			HEF	80	2754	2793	2918	2926	19.98
				90	2251	2283	2401	2401	19.98
		3750LM	SEF	80	3536	3636	3735	3824	26.47
				90	3081	3148	3237	3403	26.47
			HEF	80	3525	3575	3735	3745	25.09
				90	2882	2922	3073	3073	25.09
		5250LM	SEF	80	4755	4890	5024	5143	39.9
				90	4144	4234	4353	4577	39.9
			HEF	80	4740	4808	5024	5037	34.3
				90	3876	3930	4132	4132	34.3
		6750LM	SEF	80	6072	6243	6415	6567	54.85
				90	5292	5406	5558	5844	54.85
			HEF	80	6053	6139	6415	6432	47.97
				90	4949	5018	5276	5276	47.97
		7500LM	SEF	80	6651	6839	7027	7194	62.6
				90	5796	5922	6088	6401	62.6
			HEF	80	6630	6725	7027	7046	54.02
				90	5421	5497	5780	5780	54.02



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STEAMBOAT BASE AREA

PROMENADE AND GOLD WALK

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Issue: **BP3: GOLD WALK & PRO**
 Date: **19-May-21**
 Project #: DV20131

Type: L1,L6,L6A

CLX LED Linear**CLX OPERATIONAL DATA (continued)**

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
FDL	L48	3000LM	SEF	80	2662	2737	2812	2879	20.32
				90	2320	2370	2437	2562	20.32
			HEF	80	2654	2691	2812	2820	19.01
				90	2170	2200	2313	2313	19.01
		4000LM	SEF	80	3557	3657	3758	3847	27.58
				90	3100	3167	3256	3423	27.58
			HEF	80	3546	3596	3758	3768	24.75
				90	2899	2939	3091	3091	24.75
		5000LM	SEF	80	4450	4576	4701	4813	34.8
				90	3878	3962	4073	4283	34.8
			HEF	80	4436	4499	4701	4714	31.77
				90	3627	3678	3867	3867	31.77
		7000LM	SEF	80	6446	6628	6810	6972	49.05
				90	5618	5739	5901	6204	49.05
			HEF	80	6426	6517	6810	6829	44.67
				90	5254	5327	5602	5602	44.67
		9000LM	SEF	80	8126	8355	8584	8788	63.99
				90	7081	7234	7438	7820	63.99
			HEF	80	8100	8215	8584	8607	58.58
				90	6623	6715	7061	7061	58.58
		10000LM	SEF	80	9081	9338	9594	9822	73.37
				90	7914	8085	8313	8740	73.37
			HEF	80	9052	9181	9594	9620	66.27
				90	7402	7505	7892	7892	66.27
	L96	6000LM	SEF	80	5240	5387	5535	5667	38.15
				90	4566	4665	4796	5042	38.15
			HEF	80	5223	5297	5535	5550	35.54
				90	4270	4330	4553	4553	35.54
		8000LM	SEF	80	6991	7189	7386	7561	52.32
				90	6093	6224	6400	6728	52.32
			HEF	80	6969	7068	7386	7406	48.5
				90	5698	5778	6075	6075	48.5
		10000LM	SEF	80	8649	8893	9137	9354	66.47
				90	7537	7700	7917	8323	66.47
			HEF	80	8621	8744	9137	9161	60.89
				90	7049	7147	7516	7516	60.89
		14000LM	SEF	80	12630	12986	13342	13659	94.78
				90	11006	11244	11561	12154	94.78
			HEF	80	12589	12768	13342	13378	85.96
				90	10293	10437	10975	10975	85.96
		18000LM	SEF	80	16276	16735	17194	17602	128.98
				90	14184	14490	14898	15663	128.98
			HEF	80	16223	16454	17194	17240	116.92
				90	13265	13450	14143	14143	116.92
		20000LM	SEF	80	17976	18483	18990	19441	146.83
				90	15665	16004	16454	17300	146.83
			HEF	80	17918	18173	18990	19041	131.6
				90	14651	14855	15621	15621	131.6



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STEAMBOAT BASE AREA

PROMENADE AND GOLD WALK

14143 Denver West Pkwy, Suite 300 Golden, CO 80401 PH:(303)421.6655

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Issue: **BP3: GOLD WALK & PRO**
 Date: **19-May-21**
 Project #: DV20131

Type: L1,L6,L6A

CLX LED Linear**CLX OPERATIONAL DATA (continued)**

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
WDL	L24	1500LM	SEF	80	1377	1415	1454	1489	10.85
				90	1200	1226	1260	1325	10.85
			HEF	80	1372	1392	1454	1458	10.39
				90	1122	1138	1196	1196	10.39
		2000LM	SEF	80	1900	1953	2007	2055	14.48
				90	1656	1691	1739	1828	14.48
			HEF	80	1894	1921	2007	2012	13.46
				90	1548	1570	1651	1651	13.46
		2500LM	SEF	80	2405	2472	2540	2601	18.41
				90	2095	2141	2201	2314	18.41
			HEF	80	2397	2431	2540	2547	17.42
				90	1960	1987	2090	2090	17.42
		3500LM	SEF	80	3234	3325	3416	3497	25.83
				90	2818	2879	2960	3112	25.83
			HEF	80	3223	3269	3416	3426	25.04
				90	2636	2672	2810	2810	25.04
		4500LM	SEF	80	4634	4765	4895	5012	38.7
				90	4038	4125	4242	4459	38.7
			HEF	80	4619	4685	4895	4908	34.8
				90	3777	3829	4027	4027	34.8
		5000LM	SEF	80	4923	5062	5201	5324	41.48
				90	4290	4383	4506	4738	41.48
			HEF	80	4907	4977	5201	5215	38.11
				90	4012	4068	4278	4278	38.11
	L36	2250LM	SEF	80	2216	2279	2341	2397	16.36
				90	1931	1973	2029	2133	16.36
			HEF	80	2209	2241	2341	2348	15.47
				90	1806	1832	1926	1926	15.47
		3000LM	SEF	80	2880	2962	3043	3115	20.8
				90	2510	2564	2636	2772	20.8
			HEF	80	2871	2912	3043	3051	19.98
				90	2347	2380	2503	2503	19.98
		3750LM	SEF	80	3687	3791	3895	3987	26.47
				90	3213	3282	3375	3548	26.47
			HEF	80	3675	3727	3895	3905	25.09
				90	3005	3047	3204	3204	25.09
		5250LM	SEF	80	4958	5098	5238	5362	39.9
				90	4321	4414	4539	4772	39.9
			HEF	80	4942	5013	5238	5252	34.3
				90	4041	4097	4309	4309	34.3
		6750LM	SEF	80	6331	6510	6688	6847	54.85
				90	5517	5636	5795	6093	54.85
			HEF	80	6311	6401	6688	6706	47.97
				90	5160	5232	5502	5502	47.97
		7500LM	SEF	80	6935	7131	7326	7500	62.6
				90	6044	6174	6348	6674	62.6
			HEF	80	6913	7011	7326	7346	54.02
				90	5652	5731	6027	6027	54.02



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STEAMBOAT BASE AREA

PROMENADE AND GOLD WALK

14143 Denver West Pkwy, Suite 300 Golden, CO 80401 PH:(303)421.6655

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Issue: **BP3: GOLD WALK & PRO**
 Date: **19-May-21**
 Project #: DV20131

Type: L1,L6,L6A

CLX LED Linear**CLX OPERATIONAL DATA (continued)**

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
WDL	L48	3000LM	SEF	80	2776	2854	2932	3002	20.32
				90	2419	2471	2541	2671	20.32
			HEF	80	2767	2806	2932	2940	19.01
				90	2262	2294	2412	2412	19.01
		4000LM	SEF	80	3709	3813	3918	4011	27.58
				90	3232	3302	3395	3569	27.58
			HEF	80	3697	3749	3918	3929	24.75
				90	3023	3065	3223	3223	24.75
		5000LM	SEF	80	4640	4771	4902	5018	34.8
				90	4044	4131	4247	4465	34.8
			HEF	80	4625	4691	4902	4915	31.77
				90	3782	3834	4032	4032	31.77
		7000LM	SEF	80	6721	6911	7101	7269	49.05
				90	5857	5984	6152	6469	49.05
			HEF	80	6700	6795	7101	7120	44.67
				90	5478	5554	5841	5841	44.67
		9000LM	SEF	80	8472	8711	8950	9163	63.99
				90	7383	7543	7755	8154	63.99
			HEF	80	8445	8565	8950	8974	58.58
				90	6905	7001	7362	7362	58.58
		10000LM	SEF	80	9469	9736	10003	10240	73.37
				90	8252	8430	8667	9112	73.37
			HEF	80	9438	9573	10003	10030	66.27
				90	7717	7825	8228	8228	66.27
	L96	6000LM	SEF	80	5463	5617	5771	5908	38.15
				90	4761	4864	5001	5258	38.15
			HEF	80	5445	5523	5771	5787	35.54
				90	4452	4515	4747	4747	35.54
		8000LM	SEF	80	7289	7495	7701	7884	52.32
				90	6353	6490	6672	7015	52.32
			HEF	80	7266	7370	7701	7722	48.5
				90	5941	6024	6334	6334	48.5
		10000LM	SEF	80	9017	9272	9526	9752	66.47
				90	7858	8028	8254	8678	66.47
			HEF	80	8988	9117	9526	9552	60.89
				90	7349	7452	7836	7836	60.89
		14000LM	SEF	80	13168	13540	13911	14241	94.78
				90	11476	11723	12054	12673	94.78
			HEF	80	13126	13313	13911	13949	85.96
				90	10732	10882	11443	11443	85.96
		18000LM	SEF	80	16970	17448	17927	18353	128.98
				90	14788	15108	15533	16331	128.98
			HEF	80	16915	17156	17927	17975	116.92
				90	13831	14024	14746	14746	116.92
		20000LM	SEF	80	18742	19271	19800	20270	146.83
				90	16333	16686	17156	18037	146.83
			HEF	80	18682	18948	19800	19853	131.6
				90	15276	15489	16287	16287	131.6



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STEAMBOAT BASE AREA

PROMENADE AND GOLD WALK

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Issue: **BP3: GOLD WALK & PRO**
 Date: **19-May-21**
 Project #: DV20131

Type: L1,L6,L6A

CLX LED Linear

RRL - RELOC®-Ready Luminaire

- RRL connectors can be used with Quick-Flex®, System 820 and OnePass® systems.
- Load side of connector factory installed to luminaire.
- 4-pole mating connector with push-in terminations allows for simple installation.
- Touch-safe design on both halves meets UL/CSA requirement.
- Wiping contact design allows safe disconnect under load.



ORDERING INFORMATION

Lead times will vary depending on options selected. Consult with your sales representative.

Example: RRLA

Series	Wiring instructions
RRL RELOC®-ready luminaire	<p>A Hot conductor wired to position #1 (phase A)</p> <p>B Hot conductor wired to position #2 (phase B)</p> <p>C Hot conductor wired to position #3 (phase C) ¹</p>

Compatible RELOC® Cables for Industrial Luminaires (ordered and shipped separately)



OCS



OCU



OD



DC



PT

Notes

¹ C, ABE, and C125 options are not used with Quick-Flex QFC, Q5FC, QPT, and QD.

PRODUCT INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. PLR22 (2-circuit) and crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Note: Specifications subject to change without notice.



Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION

Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires	Branch circuits	Dimming	Ground
PLR	(blank) Not required for 22	<u>Circuits to which ballast is connected</u>	Emergency circuit connected	
PLR22	1 Black	(blank) Not required for 22	(blank) No emergency circuit	
	2 Black and red	A Black wire	ELA Emergency circuit wired to black wire	G Ground
		B Red wire	ELB Emergency circuit wired to red wire	

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits and 2-circuit (PLR 22)
- Multiple circuit with night-lights located along row as desired



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Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE

Provides years of maintenance-free illumination for indoor or outdoor use in residential & commercial applications.

CONSTRUCTION

Cast-aluminum housing with corrosion-resistant paint in an industrial grey finish.

Sealed gasket protects against moisture and dust.

OPTICS

4000K CCT LEDs.

Frosted glass diffuser provides even light distribution.

LUMEN MAINTENANCE

LEDs will deliver 70% of their initial lumens at 50,000 hour average LED life. See Lighting Facts label on page 2 for performance details.

ELECTRICAL

MVOLT driver operates on any line voltage from 120-277V

Operating temperature -40 °C to 40 °C.

4kV surge protection standard.

INSTALLATION

Mounts to ceiling or wall with surface mount junction box (included).

LISTINGS

UL Listed to U.S. and Canadian safety standards for wet locations.

Tested in accordance with IESNA LM-79 and LM-80 standards.

WARRANTY

Five-year limited warranty. Full warranty terms located at www.AcuityBrands.com/CustomerResources/Terms_and_Conditions.aspx

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications are subject to change without notice.

Outdoor General Purpose

OLVTCM & OLVTWM

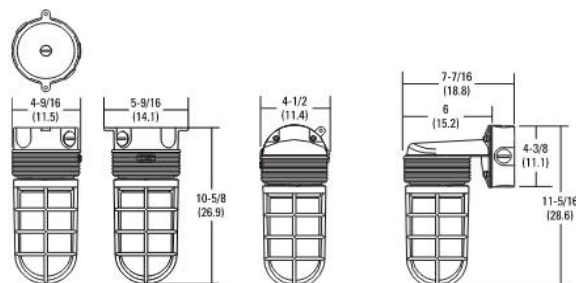


LED VAPORTIGHT



Specifications

All dimensions are inches (centimeters)



ORDERING INFORMATION

For shortest lead times, configure products using **bolded options**.

Example: OLVTCM

Series	Color temperature	Voltage	Finish
OLVTCM Ceiling MT	(blank) 4000K	(blank) MVOLT (120V-277V)	(blank) Grey
OLVTWM Wall MT			

Series	System Wattage	Lumens
OLVTCM	15W	600
OLVTWM	15W	600

DECORATIVE INDOOR & OUTDOOR

OLVT



STEAMBOAT BASE AREA PROMENADE AND GOLD WALK

14143 Denver West Pkwy, Suite 300 Golden, CO 80401 PH:(303)421.6655

www.me-engineers.com

Issue: **BP3: GOLD WALK & PRO**

Date: **19-May-21**

Project #: DV20131

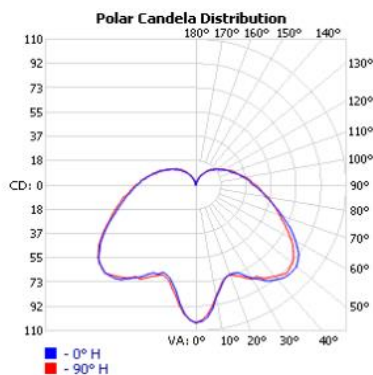
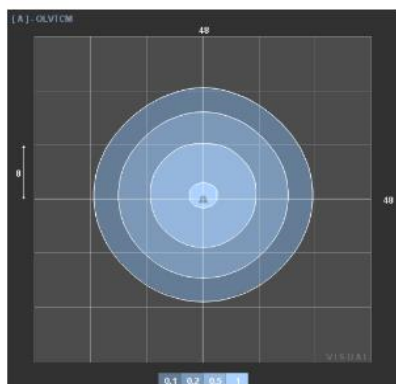
Type: L2

OLVTCM & OLVTWM LED Vaportight

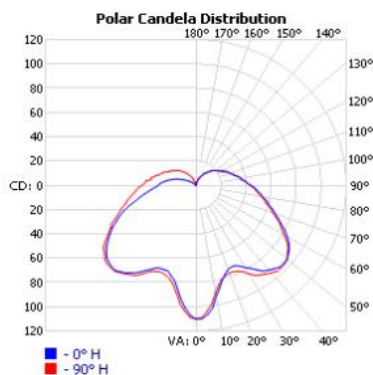
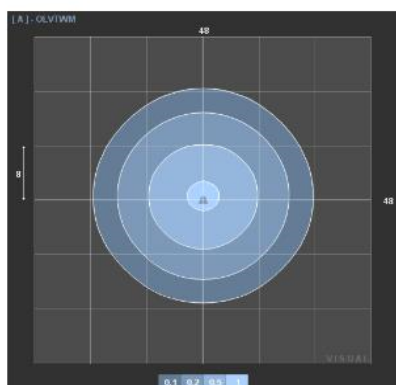
PHOTOMETRICS

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's Outdoor LED homepage
Tested in accordance with IESNA LM-79 and LM-80 standards.

OLVTCM



OLVTWM



An Acuity Brands Company

DECORATIVE INDOOR & OUTDOOR: One Lithonia Way, Conyers, GA 30012 Phone: 1-800-705-SERV (7378) www.lithonia.com

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OLVT



STEAMBOAT BASE AREA PROMENADE AND GOLD WALK

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Issue: **BP3: GOLD WALK & PRO**

Date: **19-May-21**

Project #: DV20131

Type: L2



Luminaire Type:
Catalog Number:



General Illumination Round Downlight

6"

OVERVIEW

Feature Set

- Bounding Ray™ optical design
- Unitized optics mechanically attach the light engine to the lower reflector for complete optical alignment.
- 45° cutoff to source and source image
- Fully serviceable and upgradeable lensed LED light engine
- 70% lumen maintenance at 60,000 hours
- 2.5 SDCM; 85 CRI typical, 90+ CRI optional
- Fixtures are wet location, covered ceiling
- Available with 10% dimming, 1% dimming, or dim to dark
- Batwing distribution with feathered edges provides even illumination on horizontal and vertical surfaces
- ENERGY STAR® certified product

Distribution



Superior Performance

Nominal Lumens	250	500	750	1000	1500	2000	2500	3000	3500	4000	4500	5000	6000	8000	10,000	12,000	15,000	17,500
Delivered Lumens	297	519	776	994	1471	2006	2537	3077	3542	4027	4533	5256	6371	8247	10637	12332	15776	17801
Wattage	3.4	6.2	8.2	9.6	14.7	19.7	24.7	29.5	33.8	39.0	47.3	48.7	57.6	74.9	97.1	115.0	150.9	175.3
Lumens per Watt	87.4	83.7	94.6	103.5	100.1	101.8	102.7	104.3	104.8	103.3	95.8	107.9	110.6	110.1	109.5	107.2	104.5	101.5



COMPLEMENTARY PRODUCTS

Coordinated Apertures | Multiple Layers of Light



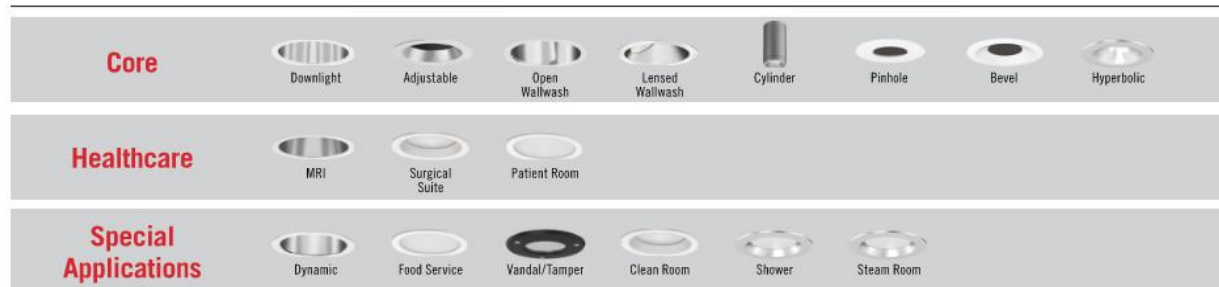
General Illumination Layer | EVO



High Center Beam Layer | Incito



EVO + Incito — Multiple Layers of Light



EVO6-OPEN
page 1 of 9

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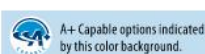
Type: L4



6"

General Illumination Round Downlight

ORDERING INFORMATION



Design2Ship Quick Ship Program: Options in green text qualify for Design2Ship — 5 business days from order entry to ship. Refer to Design2Ship Brochure for complete program details. **Maximum Order Quantity:** 100 units; 50 for Chicago Plenum.

Luminaire Type:

Catalog Number:

EXAMPLE: EVO6 35/150 AR MWD LSS MVOLT EZ1

Series	Color Temperature	Nominal Lumen Values	Reflector & Flange Color	Trim Style	Distribution
EVO6	27/ 2700 K	02 250 lumens	AR Clear	(blank) Self-flanged	VND Very Narrow (0.5 s/mh)
	30/ 3000 K	05 500 lumens	PR Pewter	FL Flangeless	ND Narrow (0.7 s/mh)
	35/ 3500 K	07 750 lumens	WTR Wheat		MD Medium (0.9 s/mh)
	40/ 4000 K	10 1000 lumens	GR Gold		MWD Medium Wide (1.0 s/mh)
	50/ 5000 K	15 1500 lumens	WR ¹ White		WD Wide (1.2 s/mh)
		20 2000 lumens	BR ¹ Black		
		25 2500 lumens	WRMF ¹ White Anti-microbial		
		30 3000 lumens			
		35 3500 lumens			

Finish	Voltage	Driver ⁴	
LSS Semi-specular	MVOLT	GZ10 0-10V driver dims to 10%	ECOS2 ⁵ Lutron® Hi-Lume® 2-wire forward-phase driver. Minimum dimming level 1%, 120V only. Minimum 1000 lumens/Maximum 4000 lumens.
LD Matte-diffuse	120	GZ1 0-10V driver dims to 1%	ECOD ⁵ Lutron Ecosystem digital Hi-Lume 1% soft-on, fade to black. Max. 4000LM.
LS Specular	277	EZ10 eldoLED 0-10V ECODrive. Linear dimming to 10% min.	
	347 ^{2,3}	EZ1 eldoLED 0-10V ECODrive. Linear dimming to 1% min.	
		EZB eldoLED 0-10V SOLOdrive. Logarithmic dimming to <1%.	
		EDAB ⁵ eldoLED SOLOdrive DALI. Logarithmic dimming to <1%.	
		EDXB ⁵ eldoLED POWERdrive DMX with RDM (remote device management). Square Law dimming to <1%. Includes termination resistor. Refer to DMXR Manual. Minimum 1000 lumens/Maximum 15000 lumens.	

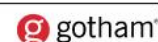
Control Interface	Options
NLT ⁶ nLight® dimming pack controls	SF Single fuse. Specify 120V or 277V.
NLTER ^{2,8,9} nLight® dimming pack controls emergency circuit	TRW ⁷ White painted flange
NLTAIR2 ¹⁰ nLight® AIR enabled	TRBL ⁴ Black painted flange
NLTAIRER2 ^{2,8,10} nLight® AIR enabled emergency	EL Emergency battery pack, 10W, with integral test switch
EXA1 XPoint Wireless, eldoLED driver. Linear dimming to 1%	ELR Emergency battery pack, 10W, with self-diagnostics, with remote test switch
EXAB XPoint Wireless, eldoLED driver. Logarithmic dimming to dark	ELSD Emergency battery pack, 10W, with self-diagnostics, integral test switch
	ELRSD Emergency battery pack, 10W, with self-diagnostics, remote test switch
	E10WCP Emergency battery pack, 10W Constant Power, CA Title 20 compliant with integral test switch
	E10WCPR Emergency battery pack, 10W Constant Power, CA Title 20 compliant with remote test switch
	N80 ¹⁰ nLight® Lumen Compensation
	BGTD Bodine generator transfer device. Specify 120V or 277V.
	90CRI High CRI (90+)
	CP ¹¹ Chicago Plenum. Specify 120V or 277V for 5000lm and above.
	HAO ¹² HAO High Ambient Option (40°C)
	RRL RELOC®-ready luminaire connectors enable a simple and consistent factory installed option across all ABL luminaire brands. Refer to RRL for complete nomenclature

ACCESSORIES — order as separate catalog numbers (shipped separately)

SCA6	Sloped ceiling adapter. Degree of slope must be specified (50, 100, 150, 200, 250, 300). Ex: SCA6 100. Refer to TECH-190 .
CTA4-8 YKHL	Ceiling thickness adapter for 10,000LM and above (extends mounting frame to accommodate ceiling thickness up to 5"). Adds ~4" to fixture height.
CTA4-8 YK	Ceiling thickness adapter for 8,000LM and below (extends mounting frame to accommodate ceiling thickness up to 5"). Adds ~4" to fixture height.
GVRT	Vandal-resistant trim accessory. Refer to TECH-200 .
ISD BC	0-10V wallbox dimmer. Refer to ISD-BC .

ORDERING NOTES

- Not available with finishes.
- Not available with emergency battery pack options.
- Supplied with factory installed step down transformer.
- Refer to [TECH-240](#) for compatible dimmers.
- Not available with nLight® and XPoint options.
- Specify voltage.
- For use with different reflector finish only (i.e. AR, PR, WTR, GR options). Not applicable with WR (white reflector) or FL (flangeless) option.
- For use with different reflector finish only (i.e. AR, PR, WTR, GR options). Not applicable with BR (black reflector) or FL (flangeless) option.
- ER for use with generator supply power. Will require an emergency hot feed and normal hot feed.
- Fixture begins at 80% light level. Must be specified with NLT or NLTER. Only available with EZ10 and EZ1 drivers.
- 12,000LM max with EL or nLight® options. 5,000LM max with Lutron drivers combined with EL. Not available with ELR, HAO, EXA1, or EXAB options.
- Only available 5000LM - 15,000LM with eldoLED drivers.
- Not available DALI or DMX drivers. Not available with CP or N80 options. Not recommended for metal ceiling installations.

EVO6-OPEN
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STEAMBOAT BASE AREA

PROMENADE AND GOLD WALK

14143 Denver West Pkwy, Suite 300 Golden, CO 80401 PH:(303)421.6655

www.me-engineers.com

Issue: **BP3: GOLD WALK & PRO**
 Date: **19-May-21**
 Project #: DV20131

Type: L4

**6"****General Illumination Round Downlight****SPECIFICATIONS****Optical Assembly**

Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from below the ceiling.
Optical design is a Bounding Ray™ design with 45° cutoff to source and source image. Top-down flash characteristic for superior glare control.
Unitized optics shall have mechanical attachment of the light engine to the lower reflector for complete optical alignment.

Electrical

The luminaire shall operate from a 50 or 60 Hz ± 3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.
Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages.
Input wires shall be 18AWG, 300V minimum, solid copper.

Controls

Luminaire shall be equipped with interface for nLight wired or wireless network with integral power supply as per specification.

Dimming

The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) over a range of 100 – 10%, 100 – 1.0% or 100 – 0.1% of rated lumen output with a smooth shut off function to step to 0%.
eLdLED LED drivers shall conform to IEEE P1789 standards. Alternatively, manufacturers must demonstrate conformance with product literature and testing which demonstrates this performance. Systems that do not meet IEEE P1789 will not be considered.
Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction

Luminaire housing shall be constructed of 16-gauge galvanized steel and have preinstalled telescopic mounting bars with maximum 32" and minimum 15" extension and 4" vertical adjustment.
Luminaires shall be suitable for installation in ceilings up to 1½" thick. (specify ceiling thickness adapter to extend frame to accommodate ceiling thickness up to 5").
Tool-less adjustments shall be possible after installation.
The assembly and manufacturing process for the luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration.
25°C ambient temperature standard (1/2" clearance on all sides from non-combustible materials in non-IC applications, unless marked spacing noted otherwise). For use in insulated ceilings, a 3" clearance on all sides from insulation is required (unless marked spacing noted otherwise). 40°C high ambient optional.

Listings

Fixtures are CSA certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, wet location covered ceiling. Luminaire configurations are Energy Star certified through testing in EPA-recognized laboratories, with the results reviewed by an independent, accredited certification organization. Visit www.energystar.gov for specific configurations listed.

Photometrics

LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.
Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 6,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by a point at the intersection of the CCT line and the black body locus line in CIE chromaticity space.

Warranty

5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions

Note:

Actual performance may differ as a result of end user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a **shaded background***
- This luminaire is part of an A+ Certified solution for nLight® control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a **shaded background***

To learn more about A+, visit www.acuitybrands.com/aplus.

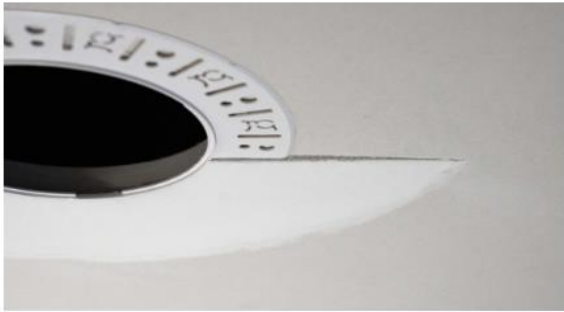
*See ordering tree for details



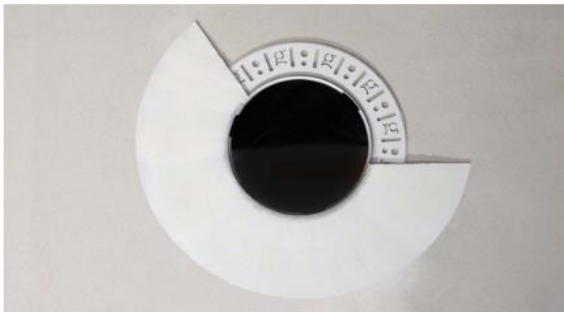
6"

General Illumination Round Downlight

Flangeless



Partially finished mud ring, showing cross-section detail.



An EVO downlight requires only approximately 3" of plaster to finish.



EVO with flangeless trim

Flangeless Installation

Gotham's flangeless option utilizes a micro-thin polymer mud ring that minimizes the amount of drywall compound required to finish the ceiling. The end result is a virtually undetectable flangeless downlight installation.

The polymer mud ring is installed independent of the recessed frame, therefore floating with the ceiling. This innovation minimizes any surface cracks during reflector installation, ceiling movement and any future service to the recessed frame, wiring, electronics, etc.



6"

General Illumination Round Downlight

Tables of Use

Marked Spacing in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
500-5000	None	None	None
6000	24	12	5
8000	36	18	11
10000			9
12000			
15000			
17500	72	36	

Marked Spacing in Inches 40°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
5000	24	12	5
6000			
8000	48	24	9
10000			
12000			
15000	72	36	9

Marked Spacing Chicago Plenum Open Frame in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
250-5000	None	None	None
6000	24	12	5
8000	36	18	11
10000			9
12000			
15000			
17500	72	36	

Marked Spacing Chicago Plenum Enclosure in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
250-5000	None	None	None
8000	36	18	6
10000	48	24	3
12000			

EVO - eidoLED Driver Default Dimming Curve			
Nomenclature	Min Dimming	Driver Dim Curve	Control Dim Curve
EZ10	10%	Linear	Linear/Logarithmic
EZ1	1%	Linear	Linear/Logarithmic
EXA1	1%	Linear	Linear/Logarithmic
EZB	<1%	Logarithmic	Linear
EDAB	<1%	Logarithmic	Linear
EXAB	<1%	Logarithmic	Linear
EDXB	<1%	Square	Linear

Lumen Output Multiplier		
CRI	CCT	Multiplier
80	2700K	0.96
	300K	1.00
	3500K	1.00
	4000K	1.01
	5000K	1.07
90	2700K	0.80
	300K	0.83
	3500K	0.85
	4000K	0.87
	5000K	0.91

Reflector Finish Multiplier	
Reflector Finish	Multiplier
LS - Specular	1
LSS - Semi Specular	0.956
WR - White	0.87
LD - Matte Diffuse	0.85
BR - Black	0.73

Distributions		
Nomenclature	Beam Angle	Field Angle
VND	30	64
ND	44	69
MD	54	82
MWD	67	89
WD	71	92

Driver		Control Provided (note: 347V/UVOLT versions provided with 347 option selected)			
Nomenclature	Description	NLT	NLTER	NLTAR2	NLTARER2
GZ10	0-10V driver dims to 10%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
GZ1	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ10	eidoLED 0-10V EC0drive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ1	eidoLED 0-10V EC0drive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZB	eidoLED 0-10V SOLOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2

How to Estimate Delivered Lumens in Emergency Mode

Delivered Lumens = 1.25 x P x LPW

P = Output power of emergency driver. P = 10W for PS1055CP

LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet.



6"

General Illumination Round Downlight

DIMENSIONAL DATA

*Dimensions in inches [centimeters]

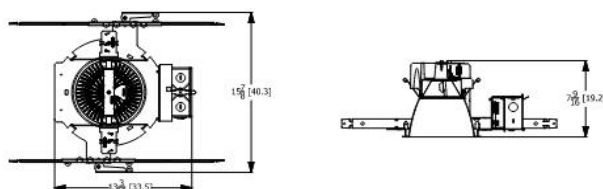
Aperture: 6 1/4" [15.9]

Ceiling Opening: 7 1/8" [18.1] self-flanged

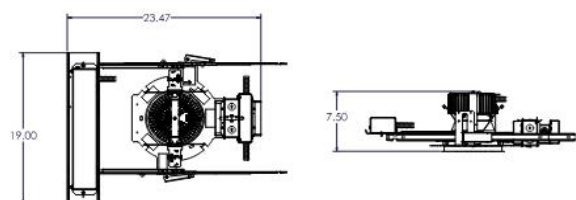
Overlap Trim: 7 1/2" [19.1]

7 1/4" [18.4] flangeless

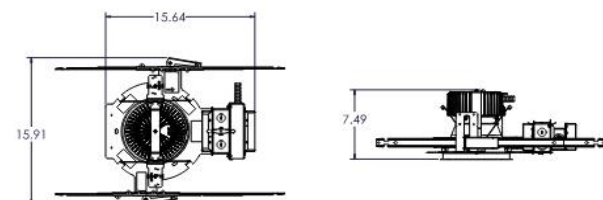
1000LM-4500LM Standard



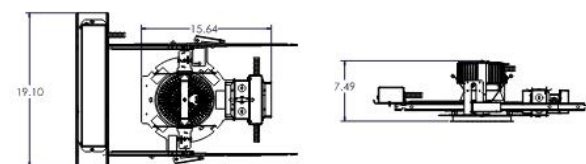
1000LM-4500LM Battery Pack



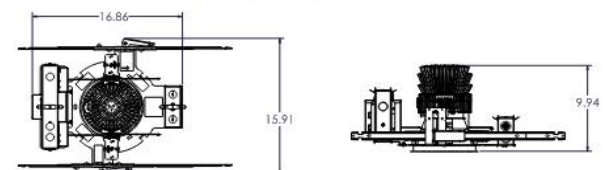
5000LM-8000LM Standard



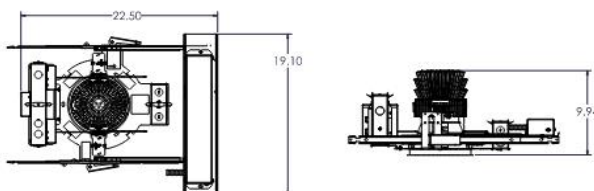
5000LM-8000LM Battery Pack



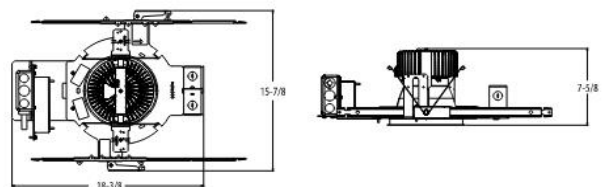
10,000LM-17,500LM Standard



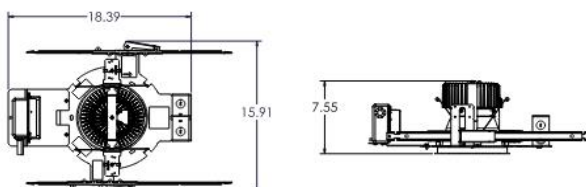
10,000LM-17,500LM Battery Pack



1000LM-4500LM CP



5000 Lumen ECO/SOLO Drive Open Frame CP



EVO6-OPEN
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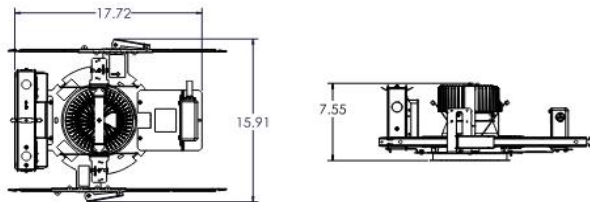
6"

General Illumination Round Downlight

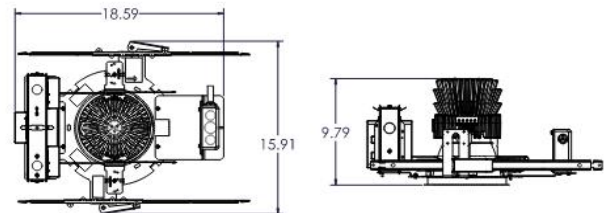
DIMENSIONAL DATA

*Dimensions in inches [centimeters]

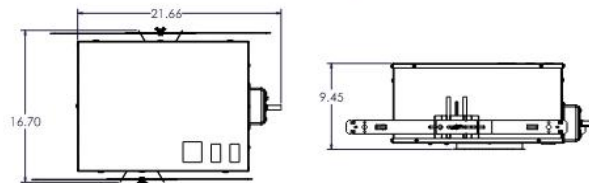
5000 (Lutron & POWER Drive Only), 6000 & 8000 Lumen Open Frame CP



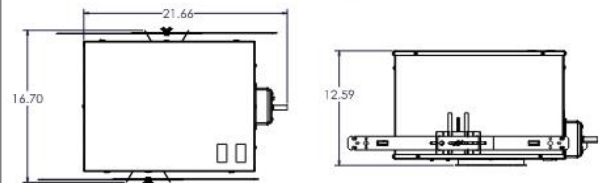
10000 - 17,500 Lumen Open Frame CP



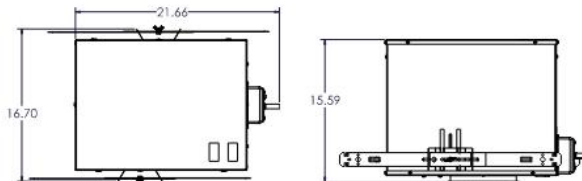
250 - 6000 Lumen CP for nLight® or Battery Pack



8,000LM Enclosed CP for nLight or Battery Pack

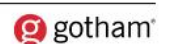


10,000LM-12,000LM Enclosed CP for nLight or Battery Pack



EVO6-OPEN
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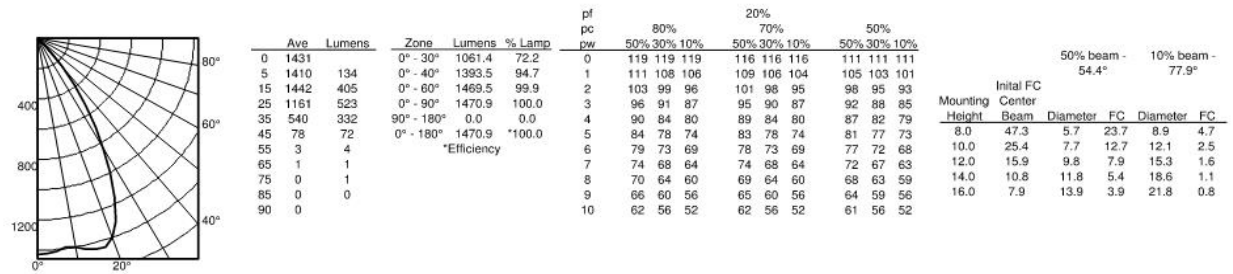
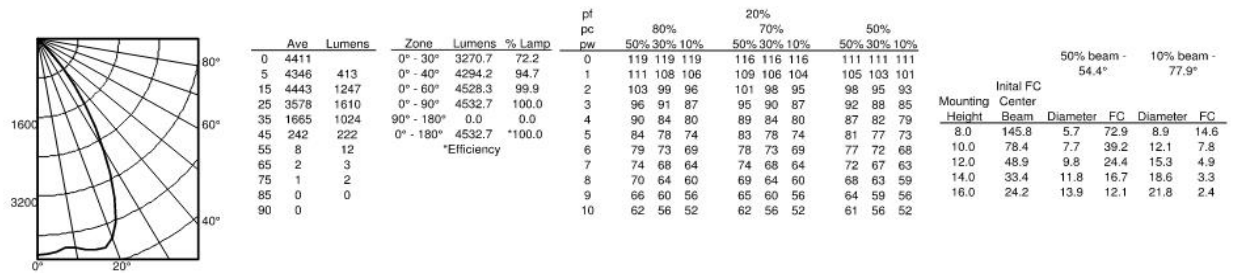
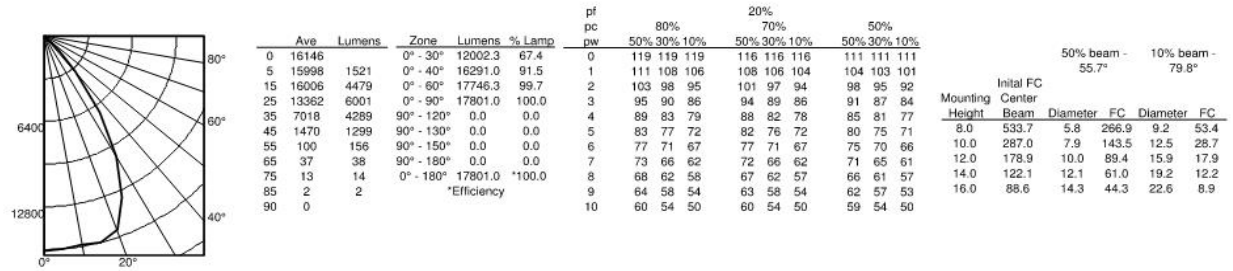
www.me-engineers.com

Issue: **BP3: GOLD WALK & PRO**
Date: **19-May-21**
Project #: DV20131

Type: L4

**6"****General Illumination Round Downlight**

Photometry

EV06 35/15 AR MWD LS INPUT WATTS: 14.7, DELIVERED LUMENS: 1471LM, LPW= 100, 1.03 S/MH, TEST NO. LTL27783P1505**EV06 35/45 AR MWD LS INPUT WATTS: 47.3, DELIVERED LUMENS: 4532.7LM, LPW= 95.8, 1.03 S/MH, TEST NO. LTL27783P1649****EV06 35/175 AR MWD LS INPUT WATTS: 175.3, DELIVERED LUMENS: 17801LM, LPW=101.5, 1.06 S/MH, TEST NO. ISF 34035P268**



6"

General Illumination Round Downlight

nLight AIR

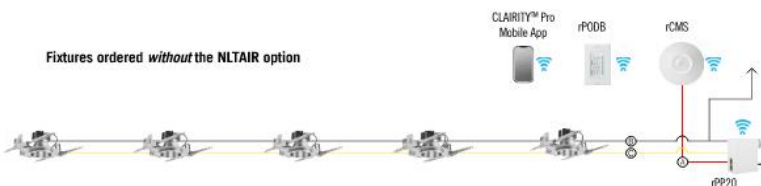
nLight® AIR is the ideal solution for retrofit or new construction spaces where adding communication wiring is cost prohibitive. The integrated nLight AIR rPP20 Power Pack is part of each EVO Luminaire ordered with the NLTAIR option. These individually addressable controls offer the ultimate in flexibility during initial setup and for space repurposing.

nLight® AIR Control AccessoriesOrder as separate catalog number. Visit [nLight AIR](#).**Wall Switches****Model Number**

On/Off single pole	rPODB (color) G2
On/Off two pole	rPODB 2P (color) G2
On/Off & raise/lower single pole	rPODB DX (color) G2
On/Off & raise/lower two pole	rPODB 2P DX (color) G2

nLight® AIR Control Accessories (cont.)**Occupancy Sensors (PIR/dual tech)****Model Number**

Small motion 360°, ceiling	rCMS 9 / rCMS PDT 9
Large motion 360°, ceiling	rCMS 10 / rCMS PDT 10

Possibilities for nLight® AIR**Fixtures ordered without the NLTAIR option****Fixtures ordered with the NLTAIR option**

nLight

nLight® The nLight® solution is a digital networked lighting control system that provides both energy savings and increased user configurability by cost effectively integrating time-based, daylight-based, sensor-based and manual lighting control schemes.

nLight® Wired Control AccessoriesOrder as separate catalog number. Visit [nLight](#).**Wall Switches****Model Number**

On/Off single pole	nPODM (color)
On/Off two pole	nPODM 2P (color)
On/Off & raise/lower single pole	nPOD DX (color)
On/Off & raise/lower two pole	nPODM 2P DX (color)
Graphic touchscreen	nPOD GFX (color)

Photocell Controls

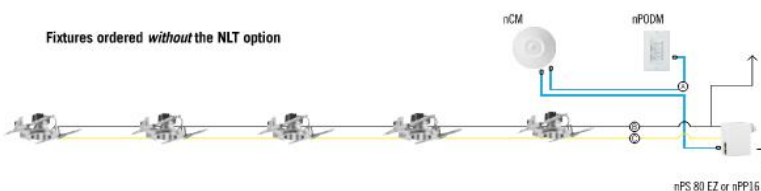
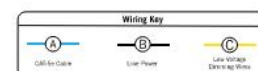
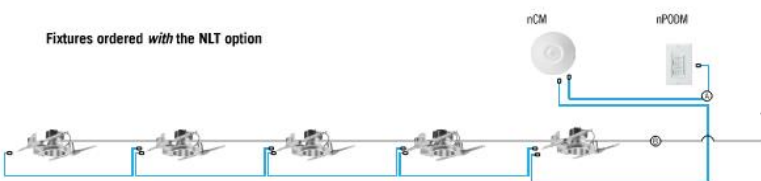
Dimming	nCM ADCX
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nLight® Wired Control Accessories (cont.)**Occupancy Sensors (PIR/dual tech)****Model Number**

Small motion 360°, ceiling	nCM 9 / nCM PDT 9
Large motion 360°, ceiling	nCM 10 / nCM PDT 10
Wide View	nWV 16 / nWV PDT 16
Wall switch with raise/lower	nWSX LV DX / nWSX PDT LV DX

Cat-5 Cables (plenum rated)

10', CAT5	CAT5 10FT J1
15', CAT5	CAT5 15FT J1

Possibilities for nLight® wired**Fixtures ordered without the NLT option****Fixtures ordered with the NLT option**



6"

General Illumination Round Downlight

nLight® AIR

nLight® AIR is the ideal solution for retrofit or new construction spaces where adding communication wiring is cost prohibitive. The integrated nLight AIR rPP20 Power Pack is part of each EVO Luminaire ordered with the NLTAIR option. These individually addressable controls offer the ultimate in flexibility during initial setup and for space repurposing.

nLight® AIR Control Accessories

Order as separate catalog number. Visit [nLight AIR](#).

Wall Switches

Model Number

On/Off single pole	rPODB (color) G2
On/Off two pole	rPODB 2P (color) G2
On/Off & raise/lower single pole	rPODB DX (color) G2
On/Off & raise/lower two pole	rPODB 2P DX (color) G2

nLight® AIR Control Accessories (cont.)

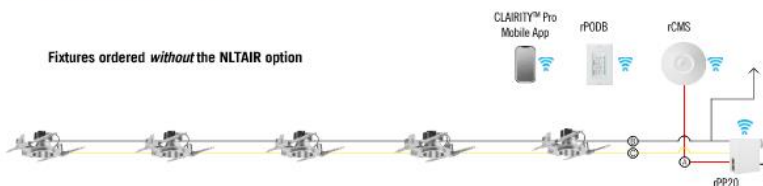
Occupancy Sensors (PIR/dual tech)

Model Number

Small motion 360°, ceiling	rCMS 9 / rCMS PDT 9
Large motion 360°, ceiling	rCMS 10 / rCMS PDT 10

Possibilities for nLight® AIR

Fixtures ordered without the NLTAIR option



Fixtures ordered with the NLTAIR option



nLight®

nLight® The nLight® solution is a digital networked lighting control system that provides both energy savings and increased user configurability by cost effectively integrating time-based, daylight-based, sensor-based and manual lighting control schemes.

nLight® Wired Control Accessories

Order as separate catalog number. Visit [nLight](#).

Wall Switches

Model Number

On/Off single pole	nPODM (color)
On/Off two pole	nPODM 2P (color)
On/Off & raise/lower single pole	nPOD DX (color)
On/Off & raise/lower two pole	nPODM 2P DX (color)
Graphic touchscreen	nPOD GFX (color)

Photocell Controls

Dimming

nCM ADCX

nLight® Wired Control Accessories (cont.)

Occupancy Sensors (PIR/dual tech)

Model Number

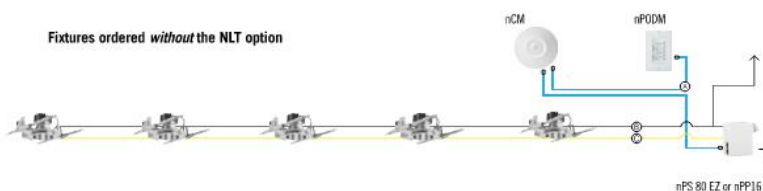
Small motion 360°, ceiling	nCM 9 / nCM PDT 9
Large motion 360°, ceiling	nCM 10 / nCM PDT 10
Wide View	nWV 16 / nWV PDT 16
Wall switch with raise/lower	nWSX LV DX / nWSX PDT LV DX

Cat-5 Cables (plenum rated)

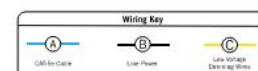
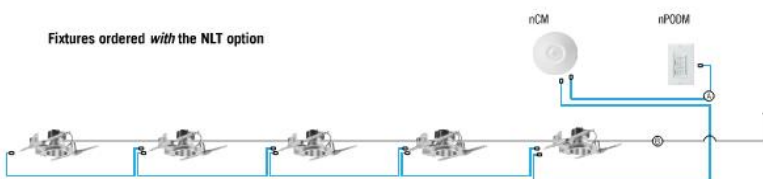
10', CAT5	CAT5 10FT J1
15', CAT5	CAT5 15FT J1

Possibilities for nLight® wired

Fixtures ordered without the NLT option



Fixtures ordered with the NLT option



SITE FAÇADE Fixtures

ASP534 LED

655-3526

1/11

we-ef**Description**

IP55. LED post top luminaire with polycarbonate lens. LED board can be easily removed to upgrade. Integrated heat sinks. Easy removal and replacement of LED board. CAD-optimized OLC® PMMA lens for multi-layer illumination and superior glare control. Optional 2200 K version available. To be specified at time of ordering.

Beam Type	[R65] Type IV Medium
Light Source	LED-24/48W / 700 mA - 3000 K
CRI	80
Gear Type	electronic gear
Nominal Luminous Flux (lm)	
LED Lumens	246 lm
LEDs	24
Total Lumens	5903 lm
Tj	85 °C
Delivered Lumens Flux (lm)	
LED Lumens	190.8 lm
Total Lumens	4578.9 lm
Ta	25 °C
Rated Input Power	55 W

WE-EF LIGHTING USA LLC

410-D Keystone Drive | Warrendale PA 15086 | U.S.A. | Tel +1 724 742 0030 | Fax +1 724 742 0035 | info.usa@we-ef.com | www.we-ef.com | 03-02-2021 23:52

**STEAMBOAT BASE AREA
PROMENADE AND GOLD WALK**

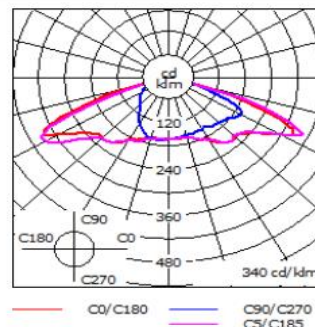
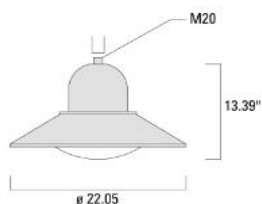
14143 Denver West Pkwy, Suite 300 Golden, CO 80401 PH:(303)421.6655


www.me-engineers.comIssue: **BP3: GOLD WALK & PRO**
Date: **19-May-21**
Project #: DV20131**Type: S1**

ASP534 LED

655-3526

2/11

we-ef**Material Specification**

Body:	Marine-grade die-cast aluminium alloy
Weight (lbs):	11.40
Lens:	Polycarbonate main lens
Colours:	<div style="display: flex; align-items: center;"> <div style="width: 20px; height: 10px; background-color: black; margin-right: 5px;"></div> <div>RAL9004 Black</div> </div> <div style="display: flex; align-items: center;"> <div style="width: 20px; height: 10px; background-color: grey; margin-right: 5px;"></div> <div>RAL9007 Grey Metallic</div> </div> <div style="display: flex; align-items: center;"> <div style="width: 20px; height: 10px; background-color: white; margin-right: 5px;"></div> <div>RAL9016 White</div> </div> <div style="display: flex; align-items: center;"> <div style="width: 20px; height: 10px; background-color: darkgrey; margin-right: 5px;"></div> <div>RAL8019 Dark Bronze</div> </div>
 ETL	ETL, UL-1598 equivalent, CSA-C22.2#250.0. Suitable for Wet Locations.
Gasket:	Silicone rubber gasket
Fasteners:	PCS Polymer Coated Stainless Steel hardware
Ingress protection:	IP55
Impact protection:	IK10
Corrosion protection:	5CE
Mounting:	Luminaire requires a mounting bracket for mounting to wall or pole. Refer to mounting accessories for wall bracket and luminaire assembly brackets
Listings:	ETL listed. Suitable for wet locations.
Windage (EPA):	0.0898 m ²

Electrical Specification

Power supply:	Integral [ECG] electronic driver 120V-277V. 0-10V dimmable, to be specified with order.
Power factor:	> 0.9
Driver / Ballast:	Integral EC electronic converter

Lifetime

Ta=25°/40° L90B10 > 90000h

BUG Rating:**WE-EF LIGHTING USA LLC**

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PROMENADE AND GOLD WALK

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www.me-engineers.comIssue: **BP3: GOLD WALK & PRO**Date: **19-May-21**

Project #: DV20131

Type: S1

ASP534 LED

655-3526

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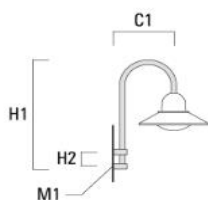
B2 U1 G1

we-ef**Mounting Accessories****Wall and pole brackets BA**

Wall and pole mounted brackets for pendant luminaires. Corrosion resistant all aluminium construction.

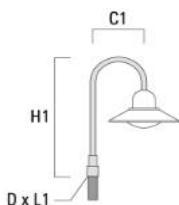
■ BA0-420 Wall bracket, single

	C1	H1	H2	M1	Weight (lbs)
655-9340	18.11	39.37	5.2	0.35	4.41 lbs



■ BA1-420 Pole bracket, single

	C1	D x L	H1	L	Weight (lbs)
655-9341	16.54	2.99 x 3.15	39.37	2.99	8.82 lbs

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Project #: DV20131

Type: S1

ASP534 LED

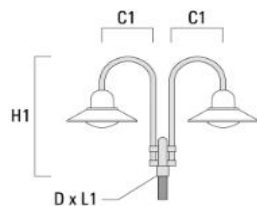
655-3526

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4/11

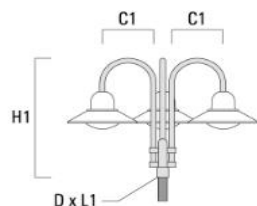
■ BA2-420 Pole bracket, double

	C1	D x L	H1	Weight (lbs)
655-9342	19.69	2.99 x 3.15	39.37	17.64 lbs



■ BA3-420 Pole bracket, triple

	C1	D x L	H1	Weight (lbs)
655-9343	19.69	2.99 x 3.15	39.37	22.05 lbs

**Wall and pole brackets DA**

Wall and pole mounted brackets for pendant luminaires. Corrosion resistant all aluminium construction.

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Project #: DV20131

Type: S1

ASP534 LED

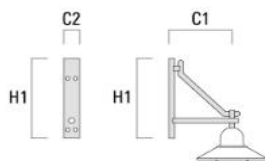
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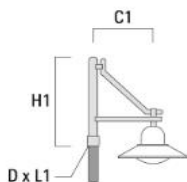
■ DA0-500 Wall bracket, single

	C1	C2	H1	Weight (lbs)
655-9361	20.08	2.76	25.59	12.57 lbs



■ DA1-500 Pole bracket, single

	C1	D x L	H1	L	Weight (lbs)
655-9362	20.08	2.99 x 3.15	27.56	2.99	12.57 lbs



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Issue: **BP3: GOLD WALK & PRO**

Date: **19-May-21**

Project #: DV20131

Type: S1

ASP534 LED

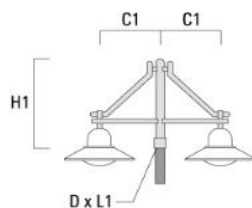
655-3526

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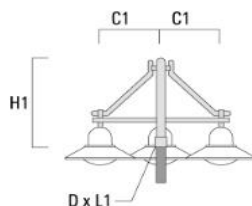
■ DA2-500 Pole bracket, double

	C1	D x L	H1	Weight (lbs)
655-9363	20.08	2.99 x 3.15	27.56	18.30 lbs



■ DA3-500 Pole bracket, triple

	C1	D x L	H1	Weight (lbs)
655-9364	20.08	2.99 x 3.15	27.56	24.03 lbs

**Wall and pole brackets DB**

Wall and pole mounted brackets. Corrosion resistant all aluminium construction.

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Project #: DV20131

Type: S1

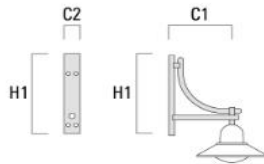
ASP534 LED 655-3526



7/11

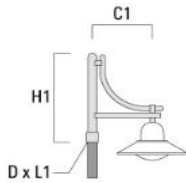
■ DB0-500 Wall bracket, single

	C1	C2	H1	Weight (lbs)
655-9365	20.08	2.76	25.59	12.13 lbs



■ DB1-500 Pole bracket, single

	C1	D x L	H1	Weight (lbs)
655-9366	20.08	2.99 x 3.15	27.56	12.13 lbs



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Issue: **BP3: GOLD WALK & PRO**
Date: **19-May-21**
Project #: DV20131

Type: S1

ASP534 LED

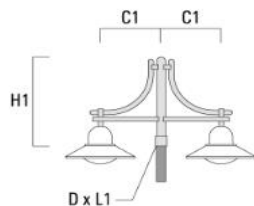
655-3526

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8/11

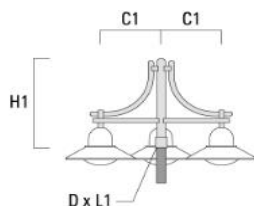
■ DB2-500 Pole bracket, double

	C1	D x L	H1	Weight (lbs)
655-9367	20.08	2.99 x 3.15	27.56	17.42 lbs



■ DB3-500 Pole bracket, triple

	C1	D x L	H1	Weight (lbs)
655-9368	20.08	2.99 x 3.15	27.56	22.71 lbs

**Wall and pole brackets DS**

Wall and pole mounted brackets. Corrosion resistant all aluminium construction.

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Project #: DV20131

Type: S1

ASP534 LED

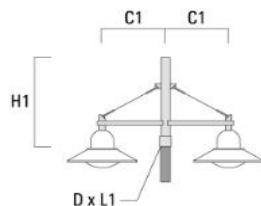
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10/11

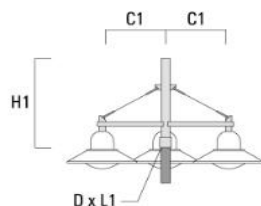
■ DS2-500 Pole bracket, double

	C1	D x L	H1	Weight (lbs)
655-9371	20.08	2.99 x 3.15	28.54	11.68 lbs



■ DS3-500 Pole bracket, triple

	C1	D x L	H1	Weight (lbs)
655-9372	20.08	2.99 x 3.15	28.54	14.77 lbs

**Electrical Accessories****Button type photocell**

Factory installed button type photocell. Photocell placed in post top head or side of bollard post. Photocell programmed for automatic dusk to dawn operation.

■ **697-8005** Button type photocell**WE-EF LIGHTING USA LLC**

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PROMENADE AND GOLD WALK

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www.me-engineers.comIssue: **BP3: GOLD WALK & PRO**Date: **19-May-21**

Project #: DV20131

Type: S1

ASP534 LED 655-3526

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Fusing

In-line fuse with fast acting circuit protection. Protects ballast from damage due to overcurrent.

■ 697-8001 Fusing



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STEAMBOAT BASE AREA PROMENADE AND GOLD WALK

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www.me-engineers.com

Issue: **BP3: GOLD WALK & PRO**
Date: **19-May-21**
Project #: DV20131

Type: S1

QRI354 LED

616-1321

1/3

we-ef**Description**

IP55. Recessed LED wall luminaire. Shielded light source. Suitable for installation in cavity wall construction or concrete pour construction using optional installation blackout.

Beam Type	asymmetric, forward-throw [A60]
------------------	---------------------------------

Light Source	LED-6/6W / 350 mA - 3000 K
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CRI	80
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Gear Type	electronic gear
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Nominal Luminous Flux (lm)

LED Lumens	134.5 lm
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LEDs	6
------	---

Total Lumens	807 lm
--------------	--------

Tj	85 °C
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Delivered Lumens Flux (lm)

LED Lumens	85.9 lm
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Total Lumens	515.5 lm
--------------	----------

Ta	25 °C
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Rated Input Power	7.7 W
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**STEAMBOAT BASE AREA**
PROMENADE AND GOLD WALK

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www.me-engineers.comIssue: **BP3: GOLD WALK & PRO**Date: **19-May-21**

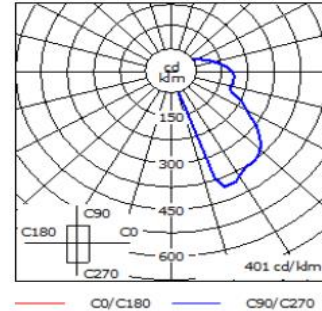
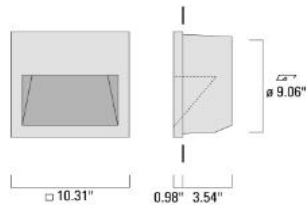
Project #: DV20131


Type: S2

QRI354 LED

616-1321

2/3

we-ef**Material Specification**

Body:	Luminaire body and lens frame constructed in die cast aluminum.
Weight (lbs):	3.40
Lens:	Tempered glass lens.
Colours:	<div style="display: flex; align-items: center;"> <div style="width: 20px; height: 10px; background-color: black; margin-right: 5px;"></div> <div>RAL9004 Black</div> </div> <div style="display: flex; align-items: center;"> <div style="width: 20px; height: 10px; background-color: grey; margin-right: 5px;"></div> <div>RAL9007 Grey Metallic</div> </div> <div style="display: flex; align-items: center;"> <div style="width: 20px; height: 10px; background-color: white; margin-right: 5px;"></div> <div>RAL9016 White</div> </div> <div style="display: flex; align-items: center;"> <div style="width: 20px; height: 10px; background-color: darkgrey; margin-right: 5px;"></div> <div>RAL8019 Dark Bronze</div> </div>
 Quick Ship	Quickship features a one week ship time for Steplights and two week ship time for the rest of our Core products. All applicable information must be included for orders to be processed and colours must be in one of our 4 standard finishes. A maximum order quantity of 30 pieces applies.
Gasket:	Silicone rubber gasket
Fasteners:	PCS polymer coated stainless steel
Ingress protection:	IP55
Impact protection:	IK08
Corrosion protection:	5CE
Mounting:	Suitable for installation in cavity wall construction or concrete pour construction using optional installation blackout.
Listings:	ETL listed. Suitable for wet locations.

Electrical Specification

Power supply:	Integral [ECG] electronic driver 120V-277V. 0-10V dimmable, to be specified with order.
Driver / Ballast:	Integral EC electronic converter
Cable:	Suitable for through wiring.

Lifetime

LED >60,000 h Ta 25°(B10/70) Control gear >50,000 h Ta 25°

Mounting Accessories**WE-EF LIGHTING USA LLC**

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STEAMBOAT BASE AREA
PROMENADE AND GOLD WALK

14143 Denver West Pkwy, Suite 300 Golden, CO 80401 PH:(303)421.6655

www.me-engineers.com

Issue: **BP3: GOLD WALK & PRO**
Date: **19-May-21**
Project #: DV20131

Type: S2

QRI354 LED

616-1321

3/3

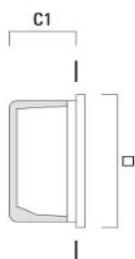
we-ef**Installation blackout**

Optional mounting accessories for concrete pour installations. Installation blackout. Suitable for installing recesses wall luminaire in concrete pour installations. Serve as rough-in housing prior to installation of luminaire. Includes hardware necessary for attachment to formwork.

■ Installation blackout BQR35-I-RE

C1**616-9319**

4.92

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www.me-engineers.comIssue: **BP3: GOLD WALK & PRO**Date: **19-May-21**

Project #: DV20131

Type: S2

ETC330-FS LED+I O - 180° (ETC/ETV_30-FS LED)

611-3823+611-7212

1/6

we-ef**Description**

IP67. Inground uplight. Suitable for flush installation in concrete or earth. Special effects and distributions can be realized with linear lens, flood lens, 6° directional lens, 20° directional lens, or color filters.

Beam Type linear spread, very narrow beam [VN]**Light Source** LED-12/24W / 700 mA - 3000 K**CRI** 80**Gear Type** electronic gear**Nominal Luminous Flux (lm)**

LED Lumens 245.9 lm

LEDs 12

Total Lumens 2951 lm

Tj 85 °C

Delivered Lumens Flux (lm)

LED Lumens 188.1 lm

Total Lumens 2257.3 lm

Ta 25 °C

Rated Input Power 28 W**WE-EF LIGHTING USA LLC**

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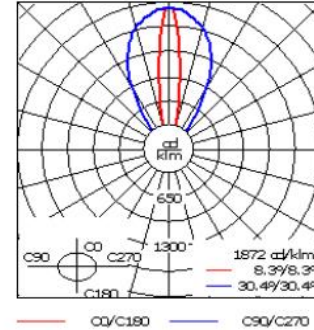
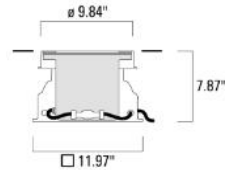
Type: S3



ETC330-FS LED+I O - 180° (ETC/ETV_30-FS LED)

611-3823+611-7212

we-ef

2/6

**Material Specification**

Body:	Luminaire body constructed of deep drawn stainless steel. Outer housing composite material.
Weight (lbs):	22.00
Lens:	Safety glass lens, max. load 5 tonnes
Colours:	 Stainless Steel
 Lightspeed	Need Fixtures Fast? Ask for LIGHTSPEED. LIGHTSPEED features a 5-day dispatch guaranteed on CORE products, or 25% back! Our CORE Products include 80+ subfamilies, available in 4 standard finishes. Standard dispatch of CORE products is 2-weeks. Maximum order quantities apply.
Fasteners:	PCS polymer coated stainless steel
Ingress protection:	IP67
Impact protection:	IK10+
Corrosion protection:	5CE
Mounting:	Suitable for installation in concrete or earth. Suitable for walk-over and drive-over applications. Proper drainage and foundation support must be provided.

Electrical Specification

Power supply:	Integral [ECG] electronic driver 120V-277V. 0-10V dimmable, to be specified with order.
Termination:	Factory sealed termination chamber
Cable:	3 feet of flexible 18/3 cable

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Type: S3

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611-3823+611-7212

we-ef

3/6

Lifetime

LED >60,000 h Ta 25°C (L70/B10) Control gear >50,000 h Ta 25°C

Dimming

0-10V available in request. Must be factory fitted.

Optical Accessories**Softening Lens**

Softens light distribution in all planes. Reduces light intensity and improves visual comfort. Will slightly widen the native light distribution.

C1■ **611-7209** Flood lens IO-360

6.30

**Honeycomb louvre**

Honeycomb louvre, matt black Teflon® coated. For luminaires equipped with [M] [EE] [EES] light distribution.

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4/6

C1■ **611-7218** Honeycomb Louvre IW

7.52

**Linear spread lens**

Broadens light distribution in one plane only. Normally used with very narrow beam reflector. Internal component, factory installed.

C1■ **611-7212** Linear spread lens IO-180

6.30

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ETC330-FS LED+I O - 180° (ETC/ETV_30-FS LED)

611-3823+611-7212

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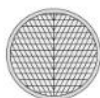
5/6

Wallwash lens

Specifically developed for the lighting of architectural surfaces, in combination with WE-EF [M] symmetric medium beam LED optics. Luminaires fitted with the IO-20 wallwash lens are typically positioned at $0.125 \times h$ away from the target surface and spaced up to $1.75 \times d$ apart: h = height of wall/target surface $d = 0.125 \times h$ = distance from the wall/target surface $s = 1.75 \times d$ = spacing between luminaires The IO-20 LED wallwash lens is factory-installed within the luminaire. The factory-sealed qualities and advantages of the luminaire are fully maintained.

C1■ **630-8150** Wallwash lens IO-20

6.30



C1

ASC Lens

Anti-Slip ceramic Coating ASC to DIN 51130 (Trip Classification 10)

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ETC330-FS LED+I O - 180° (ETC/ETV_30-FS LED)

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C1■ **611-7203** ETC330 ASC Lens

6.26

**Electrical Accessories****Sealable junction box**

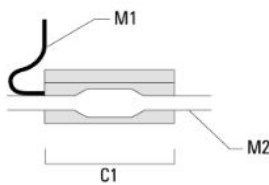
SJB sealable junction box, for inground mains connection. Provided with 3 UL4860 connectors

C1**M1****M2**■ **697-8072** Sealable junction box SJB 130

5.75

Ø 0.39

Ø 0.47 - 0.75

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Project #: DV20131

Type: S3

EMERGENCY Fixtures



FEATURES & SPECIFICATIONS

INTENDED USE — Suitable for applications requiring attractive edge-lit exit signage, universal installation and low energy consumption.

CONSTRUCTION — Extruded brushed aluminum finish.

Clear acrylic panels- letters measure 6" high with 3/4" stroke, with 100 ft viewing distance rating, based upon UL 924 standard.

For single-face clear panels, EXIT is seen as a reversed image from the back.

OPTICS — LEDs mounted on printed circuit board. The typical life of the exit LED lamp is 10 years.

The LED operating frequency is 120Hz.

ELECTRICAL — Dual voltage input capacity (120/277V).

Battery: (EL Option) — Sealed, maintenance free nickel-cadmium battery delivers 90 minutes capacity to emergency lamps. Test switch provides manual activation of 30-second diagnostic testing for on-demand visual inspection.

Self-diagnostic testing (EL Option Only) for 30 seconds every 30 days and 90 minutes annually. Diagnostic evaluation of LED light source, AC to DC transfer, charging and battery condition.

INSTALLATION — EDG — Universal mounting canopy for top or end mount. Back mount standard for single face only. Canopy provided.

EDGR — Recessed mounting. Bar hanger and brackets provided for both new or restricted ceiling access installation applications. Back wall mount (WM) option.

Universal directional indicators. Field selected and attached.

LISTINGS — UL damp location listed 32°-122°F (0°-50°C) standard. Meets UL924, NFPA 101 (current Life Safety Code), NEC and OSHA illumination standards. Meets all applicable FCC Title 47, Part 15, Subpart B requirements.

WARRANTY — 5-year limited warranty. Complete warranty terms located at:

www.acuitybrands.com/support/customer-support/terms-and-conditions

NOTE: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25°C.

Specifications subject to change without notice.

† Exit Signs Certified in the CA Title 20 Appliance Efficiency Database.

Catalog Number	
Notes	
Type	



EDG (surface mount)



EDGR (recessed mount)

LED Edge-Lit Exits

EDG EDGR

LED Lamps



Specifications

EDG (End Mount) Length: 13-5/8 (34.6) Depth: 5-1/2 (14.0) Height: 11-1/8 (28.3) Shipping Weight: 4 lbs (1.8 kgs)	EDG (Top Mount) Length: 13 (33.0) Depth: 4-5/16 (11.0) Height: 11-3/4 (29.8) Shipping Weight: 4 lbs (1.8 kgs)
EDG (Back Mount) Length: 13 (33.0) Depth: 3 (7.6) Height: 11-1/8 (28.3) Shipping Weight: 4 lbs (1.8 kgs)	EDGR Length: 13 (33.0) Depth: 1-3/4 (4.4) Height: 8 (20.3) Shipping Weight: 6.8 lbs (3.1 kgs) Shipping Weight (WM option): 8.1 lbs (3.7 kgs)

All dimensions are inches (centimeters) unless otherwise noted.

ORDERING INFORMATION For shortest lead times, configure products using **bolded options**.

Example: EDG 1 R EL

Family	Housing color	Number of faces	Letter color	Operations	Options
EDG Surface mount LED edge-lit exit	(blank) Brushed aluminum	1 Single face	R Red on clear (single face only) ¹	(blank) AC only	(blank) None
EDGR Recessed LED edge-lit exit	W White	2 Double face	G Green on clear (single face only) ¹	EL Nickel-cadmium battery	WM Recessed wall mount ⁸
			RMR Red on mirror ²	X2 Lamp wired on two separate AC circuits (specify 120V or 277V) ⁴	
			GMR Green on mirror ²	SD Self-diagnostics ⁵	
			RW Red on white ³		
			GW Green on white ³		

Accessories: Order as separate item.

ELA US12	12" stem kit with brushed aluminum canopy ⁷
ELAW US12	12" stem kit with white canopy ⁷
ELAWG1	Wireguard ⁸

Notes

- For single-face clear panels, EXIT is seen as a reversed image from the back.
- Available with single and double face.
- White panel standard for double and single face.
- Not available with EL and SD options. Both circuits can be energized at the same time.
- Available with EL option only.
- Available on EDGR single face only.
- See spec sheet [ELA-StemKits](#). Only available for EDG.
- Back mount only.

EMERGENCY

EDG-EDGR



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Date: **19-May-21**

Project #: DV20131

Type: X1

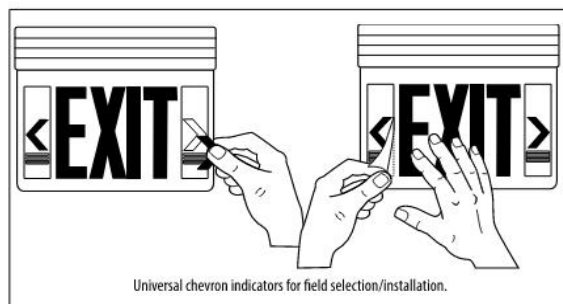
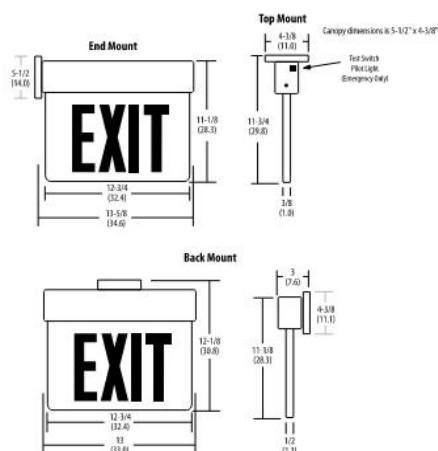
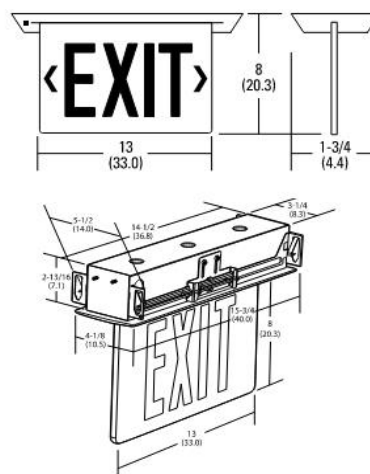
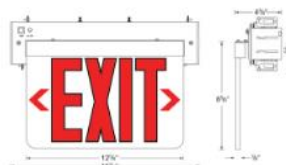
EDG-EDGR LED, Surface and Recessed Mount Edge-Lit Exits**SPECIFICATIONS**

ELECTRICAL						
Primary Circuit						
Type	Typical LED life ¹	Supply voltage	EDG		EDGR	
			Input Watts	Max amps.	Input Watts	Max amps.
Red LED AC only	10 years	120	2.5	0.020	3.8	0.030
		277	2.8	0.010	4.5	0.014
Green LED AC only	10 years	120	2.2	0.020	3.8	0.030
		277	2.2	0.010	4.5	0.020
Red LED emergency	10 years	120	3.0	0.030	3.8	0.031
		277	3.1	0.010	4.5	0.015
Green LED emergency	10 years	120	2.6	0.020	3.8	0.031
		277	2.8	0.010	4.5	0.020

BATTERY (EL option)			
Sealed Nickel-Cadmium			
Shelf life ²	Typical life ³	Maintenance ³	Temperature range ⁴
3 years	7-9 years	none	32-122°F (0-50°C)

Notes

- Based on continuous operation. The typical life of the exit LED lamp is 10 years.
- At 77°F (25°C).
- All life safety equipment, including emergency lighting for path of egress must be maintained, serviced, and tested in accordance with all National Fire Protection Association (NFPA) and local codes. Failure to perform the required maintenance, service, or testing could jeopardize the safety of occupants and will void all warranties.
- Optimum ambient temperature range where unit will provide capacity for 90 minutes. Higher and lower temperatures affect life and capacity.

KEY FEATURES**MOUNTING****EDG****EDGR****EDGR WM option**

EDG-EDGR

EMERGENCY: One Lithonia Way, Conyers, GA 30012 Phone: 800-705-SERV (7378) techsupport-emergency@acuitybrands.com www.lithonia.com

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Type: X1