

SPECIFICATIONS MANUAL
50% Construction Documents
ALW Project No. 21414

October 7, 2021

North Florida Innovation Labs

Leon County Research & Development Authority

Architect



Architects Lewis + Whitlock
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**Project: Leon County R&D Authority – North Florida Innovation Labs
BNI Project No.: 21T08**

50% Construction Documents

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STRUCTURAL SPECIFICATION INDEX

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SECTION 032000 -	CONCRETE REINFORCEMENT
SECTION 033000 -	CAST-IN-PLACE CONCRETE
SECTION 042900 -	REINFORCED MASONRY
SECTION 051200 -	STRUCTURAL STEEL
SECTION 053100 -	STEEL DECK
SECTION 054000 -	COLD FORMED METAL FRAMING

(The sections listed above are provided by Bliss & Nyitray, Inc. (Engineering Business No. 674) for the above referenced Project.)

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**SECTION 011000
SUMMARY**

PART 1 GENERAL

1.01 PROJECT

- A. Project Name: North Florida Innovation Labs
- B. Owner's Name: Leon County Research and Development Authority.
- C. Architect's Name: Architects Lewis + Whitlock, PA.
- D. The project scope includes construction of a new one-story high-tech business incubator, approximately 40,000 GSF in size sited on 3.51 acres located in Innovation Park, Tallahassee, Florida. The project includes site site work, utility connections and a complete building package as described in the 100% Construction Documents.

1.02 CONTRACT DESCRIPTION

- A. Contract Type: A single prime contract based on a Stipulated Price as described in Document 005000 - Contracting Forms and Supplements.

1.03 OWNER OCCUPANCY

- A. Owner intends to occupy the Project upon Substantial Completion.
- B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
- C. Schedule the Work to accommodate Owner occupancy.

1.04 CONTRACTOR USE OF SITE AND PREMISES

- A. Construction Operations: Limited to areas noted on Drawings.
- B. Provide access to and from site as required by law and by Owner:
 - 1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
 - 2. Do not obstruct roadways, sidewalks, or other public ways without permit.

1.05 WORK SEQUENCE

- A. Coordinate construction schedule and operations with Architect.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 011000

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**SECTION 012300
ALTERNATES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Description of Alternates.

1.02 ACCEPTANCE OF ALTERNATES

- A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at Owner's option. Accepted Alternates will be identified in the Owner-Contractor Agreement.
- B. Coordinate related work and modify surrounding work to integrate the Work of each Alternate.

1.03 SCHEDULE OF ALTERNATES

- A. Alternate No. 1 - Entry Canopy
 - 1. Provide complete foundation, structural steel, roof canopy, and paint.
- B. Alternate No. 2 - Extended North Porch.
 - 1. Provide extended north porch as indicated.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 012300

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**SECTION 012500
SUBSTITUTION PROCEDURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Procedural requirements for proposed substitutions.

1.02 RELATED REQUIREMENTS

- A. Section 004325 - Substitution Request Form - During Procurement: Required form for substitution requests made prior to award of contract (During procurement).
- B. Section 006325 - Substitution Request Form - During Construction: Required form for substitution requests made after award of contract (During construction).
- C. Section 012300 - Alternates, for product alternatives affecting this section.
- D. Section 013000 - Administrative Requirements: Submittal procedures, coordination.
- E. Section 016000 - Product Requirements: Fundamental product requirements, product options, delivery, storage, and handling.

1.03 DEFINITIONS

- A. Substitutions: Changes from Contract Documents requirements proposed by Contractor to materials, products, assemblies, and equipment.
 - 1. Substitutions for Cause: Proposed due to changed Project circumstances beyond Contractor's control.
 - 2. Substitutions for Convenience: Proposed due to possibility of offering substantial advantage to the Project.
 - a. Substitution requests offering advantages solely to the Contractor will not be considered.
- B. Substitutions: See General Conditions for definition.

1.04 REFERENCE STANDARDS

- A. CSI/CSC Form 1.5C - Substitution Request (During the Bidding/Negotiating Stage) Current Edition.
- B. CSI/CSC Form 13.1A - Substitution Request (After the Bidding/Negotiating Phase) Current Edition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
 - 2. Agrees to provide the same warranty for the substitution as for the specified product.
 - 3. Agrees to provide same or equivalent maintenance service and source of replacement parts, as applicable.
 - 4. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
 - 5. Waives claims for additional costs or time extension that may subsequently become apparent.
 - 6. Agrees to reimburse Owner and Architect for review or redesign services associated with re-approval by authorities.
- B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.
 - 1. Note explicitly any non-compliant characteristics.

- C. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.
 - 1. Forms indicated in the Project Manual are adequate for this purpose, and must be used.
- D. Limit each request to a single proposed substitution item.
 - 1. Submit an electronic document, combining the request form with supporting data into single document.

3.02 SUBSTITUTION PROCEDURES DURING PROCUREMENT

- A. Submittal Time Restrictions:
 - 1. Owner will consider requests for substitutions only if submitted at least 10 days prior to the date for receipt of bids.
- B. Submittal Form (before award of contract):
 - 1. Submit substitution requests by completing CSI/CSC Form 1.5C - Substitution Request. See this form for additional information and instructions. Use only this form; other forms of submission are unacceptable.

3.03 SUBSTITUTION PROCEDURES DURING CONSTRUCTION

- A. Submittal Form (after award of contract):
 - 1. Submit substitution requests by completing CSI/CSC Form 13.1A - Substitution Request (After Bidding/Negotiating). See this form for additional information and instructions. Use only this form; other forms of submission are unacceptable.
- B. Submit request for Substitution for Cause immediately upon discovery of need for substitution, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.
- C. Submit request for Substitution for Convenience immediately upon discovery of its potential advantage to the project, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.
 - 1. In addition to meeting general documentation requirements, document how the requested substitution benefits the Owner through cost savings, time savings, greater energy conservation, or in other specific ways.
 - 2. Document means of coordinating of substitution item with other portions of the work, including work by affected subcontractors.
 - 3. Bear the costs engendered by proposed substitution of:
 - a. Owner's compensation to the Architect for any required redesign, time spent processing and evaluating the request.
 - b. Other construction by Owner.
 - c. Other unanticipated project considerations.
- D. Substitutions will not be considered under one or more of the following circumstances:
 - 1. When they are indicated or implied on shop drawing or product data submittals, without having received prior approval.
 - 2. Without a separate written request.
 - 3. When acceptance will require revisions to Contract Documents.

3.04 RESOLUTION

- A. Architect may request additional information and documentation prior to rendering a decision. Provide this data in an expeditious manner.
- B. Architect will notify Contractor in writing of decision to accept or reject request.
 - 1. Architect's decision following review of proposed substitution will be noted on the submitted form.

3.05 ACCEPTANCE

- A. Accepted substitutions change the work of the Project. They will be documented and incorporated into work of the project by Change Order, Construction Change Directive, Architectural Supplementary Instructions, or similar instruments provided for in the Conditions of the Contract.

END OF SECTION 012500

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**SECTION 013000
ADMINISTRATIVE REQUIREMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electronic document submittal service.
- B. Preconstruction meeting.
- C. Progress meetings.
- D. Coordination drawings.
- E. Submittals for review, information, and project closeout.
- F. Number of copies of submittals.
- G. Submittal procedures.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 ELECTRONIC DOCUMENT SUBMITTAL SERVICE

- A. All documents transmitted for purposes of administration of the contract are to be in electronic (PDF) format.
 - 1. This procedure applies to requests for information (RFIs), shop drawings, information submittals, field reports, meeting minutes, and any other document any participant wishes to make part of the project record.
 - 2. It is Contractor's responsibility to submit documents in allowable format.
 - 3. Paper document transmittals will not be reviewed.
 - 4. All other specified submittal and document transmission procedures apply, except that electronic document requirements do not apply to samples or color selection charts.

3.02 PRECONSTRUCTION MEETING

- A. Schedule meeting after Notice of Award.
- B. Attendance Required:
 - 1. Owner.
 - 2. Architect.
 - 3. Contractor.
- C. Agenda:
 - 1. Submission of list of subcontractors, list of products, schedule of values, and progress schedule.
 - 2. Designation of personnel representing the parties to Contract, [] and .
 - 3. Scheduling.
- D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.03 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the Work at maximum Bi-weekly intervals.
- B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.
- C. Attendance Required:
 - 1. Contractor.
 - 2. Owner.
 - 3. Architect.
 - 4. Contractor's superintendent.
- D. Agenda:

1. Review minutes of previous meetings.
 2. Review of work progress.
 3. Field observations, problems, and decisions.
 4. Identification of problems that impede, or will impede, planned progress.
 5. Review of submittals schedule and status of submittals.
 6. Maintenance of progress schedule.
 7. Corrective measures to regain projected schedules.
 8. Planned progress during succeeding work period.
 9. Maintenance of quality and work standards.
 10. Effect of proposed changes on progress schedule and coordination.
 11. Other business relating to work.
- E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.04 SUBMITTALS FOR REVIEW

- A. When the following are specified in individual sections, submit them for review:
1. Product data.
 2. Shop drawings.
 3. Samples for selection.
 4. Samples for verification.
- B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in the contract documents.
- C. Samples will be reviewed for aesthetic, color, or finish selection.
- D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 017800 - Closeout Submittals.

3.05 SUBMITTALS FOR INFORMATION

- A. When the following are specified in individual sections, submit them for information:
1. Design data.
 2. Certificates.
 3. Test reports.
 4. Inspection reports.
 5. Manufacturer's instructions.
 6. Manufacturer's field reports.
 7. Other types indicated.
- B. Submit for Architect's knowledge as contract administrator or for Owner.

3.06 SUBMITTALS FOR PROJECT CLOSEOUT

- A. Submit Correction Punch List for Substantial Completion.
- B. Submit Final Correction Punch List for Substantial Completion.
- C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 017800 - Closeout Submittals:
1. Project record documents.
 2. Operation and maintenance data.
 3. Warranties.
 4. Bonds.
 5. Other types as indicated.
- D. Submit for Owner's benefit during and after project completion.

3.07 NUMBER OF COPIES OF SUBMITTALS

- A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.

- B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.
 - 1. After review, produce duplicates.
 - 2. Retained samples will not be returned to Contractor unless specifically so stated.

3.08 SUBMITTAL PROCEDURES

- A. General Requirements:

END OF SECTION 013000

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**SECTION 014000
QUALITY REQUIREMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing and inspection agencies and services.
- B. Control of installation.
- C. Mock-ups.
- D. Tolerances.
- E. Manufacturers' field services.
- F. Defect Assessment.

1.02 REFERENCE STANDARDS

- A. ASTM C1021 - Standard Practice for Laboratories Engaged in Testing of Building Sealants 2008 (Reapproved 2019).
- B. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation 2017.
- C. ASTM C1093 - Standard Practice for Accreditation of Testing Agencies for Masonry 2019.
- D. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction 2019.
- E. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection 2021.
- F. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing 2021.

1.03 TESTING AND INSPECTION AGENCIES AND SERVICES

- A. Contractor shall employ and pay for services of an independent testing agency to perform other specified testing.
- B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.
- C. Contractor Employed Agency:
 - 1. Testing agency: Comply with requirements of ASTM E329, ASTM E543, ASTM C1021, ASTM C1077, ASTM C1093, and ASTM D3740.
 - 2. Laboratory: Authorized to operate in the State in which the Project is located.

PART 3 EXECUTION

2.01 CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.
- D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Have work performed by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

2.02 MOCK-UPS

- A. Tests shall be performed under provisions identified in this section and identified in the respective product specification sections.
- B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- C. Accepted mock-ups shall be a comparison standard for the remaining Work.
- D. Where mock-up has been accepted by Architect and is specified in product specification sections to be removed, protect mock-up throughout construction, remove mock-up and clear area when directed to do so by Architect.

2.03 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

2.04 TESTING AND INSPECTION

- A. Testing Agency Duties:
 - 1. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
 - 2. Perform specified sampling and testing of products in accordance with specified standards.
 - 3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 - 4. Promptly notify Architect and Contractor of observed irregularities or non-compliance of Work or products.
 - 5. Perform additional tests and inspections required by Architect.
 - 6. Submit reports of all tests/inspections specified.
- B. Limits on Testing/Inspection Agency Authority:
 - 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency may not approve or accept any portion of the Work.
 - 3. Agency may not assume any duties of Contractor.
 - 4. Agency has no authority to stop the Work.
- C. Contractor Responsibilities:
 - 1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
 - 2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
 - 3. Provide incidental labor and facilities:
 - a. To provide access to Work to be tested/inspected.
 - b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
 - c. To facilitate tests/inspections.
 - d. To provide storage and curing of test samples.
 - 4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
 - 5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
 - 6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
- D. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Architect.

- E. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.

2.05 MANUFACTURERS' FIELD SERVICES

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance equipment, and [] as applicable, and to initiate instructions when necessary.
- B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

2.06 DEFECT ASSESSMENT

- A. Replace Work or portions of the Work not complying with specified requirements.

END OF SECTION 014000

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**SECTION 016000
PRODUCT REQUIREMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General product requirements.
- B. Sustainable design-related product requirements.
- C. Re-use of existing products.
- D. Transportation, handling, storage and protection.
- E. Product option requirements.
- F. Substitution limitations.
- G. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 RELATED REQUIREMENTS

- A. Section 012500 - Substitution Procedures: Substitutions made during procurement and/or construction phases.
- B. Section 013329.02 - Sustainable Design Reporting - LEED v4: Reporting requirements.
- C. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions: Requirements for VOC-restricted product categories.
- D. Section 017419 - Construction Waste Management and Disposal: Waste disposal requirements potentially affecting product selection, packaging and substitutions.

1.03 REFERENCE STANDARDS

- A. C2C (DIR) - C2C Certified Products Registry; Cradle to Cradle Products Innovation Institute Current Edition.
- B. EN 15804 - Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products 2014.
- C. GreenScreen (LIST) - GreenScreen for Safer Chemicals List Translator; Clean Production Action Current Edition.
- D. GreenScreen (METH) - GreenScreen for Safer Chemicals Method v1.2; Clean Production Action Current Edition.
- E. ISO 14025 - Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures 2006 (Confirmed 2020).
- F. ISO 14040 - Environmental management - Life cycle assessment - Principles and framework 2006 (Amended 2020).
- G. ISO 14044 - Environmental management - Life cycle assessment - Requirements and guidelines 2006 (Amended 2020).
- H. ISO 21930 - Sustainability in buildings and civil engineering works -- Core rules for environmental product declarations of construction products and services 2017.

1.04 SUBMITTALS

- A. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- B. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- C. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.
- D. Sustainable Design Submittals: Items necessary to document use of sustainable construction materials, products, and practices.
 1. See Section 013329.02 for Contractor's reporting necessary for achievement of targeted LEED v4 certification level.

1.05 QUALITY ASSURANCE

- A. Chain-of-Custody (COC): A procedure that tracks a product from the point of harvest or extraction to its end use, including successive stages of processing, transformation, manufacturing, and distribution.
- B. Chain-of-Custody Certificates: Certificates signed by manufacturers and fabricators 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.
- C. Composite Wood and Agrifiber: Products made of wood particles and/or plant material pressed and bonded with adhesive or resin such as particleboard, medium density fiberboard (MDF), plywood, wheatboard, strawboard, panel substrates, and door cores.
- D. Corporate Sustainability Report: A third-party verified report that outlines the environmental impacts of extraction operations and activities associated with the manufacturer's product and the product's supply chain.
- E. Cradle-to-Cradle Certified: End use product certified Cradle-to-Cradle v2 Basic or Cradle-to-Cradle v3 Bronze, minimum, as evidenced by C2C (DIR).
- F. Environmental Product Declaration (EPD): Publicly available, critically reviewed life cycle analysis having at least a cradle-to-gate scope.
 1. Good: Product-specific; compliant with ISO 14044.
 2. Better: Industry-wide, generic; compliant with ISO 21930, or with ISO 14044, ISO 14040, ISO 14025, and EN 15804; Type III third-party certification with external verification, in which the manufacturer is recognized as the program operator.
 3. Best: Commercial-product-specific; compliant with ISO 21930, or with ISO 14044, ISO 14040, ISO 14025, and EN 15804; Type III third-party certification with external verification, in which the manufacturer is recognized as the program operator.
 4. Where demonstration of impact reduction below industry average is required, submit both industry-wide and commercial-product-specific declarations; or submit at least 5 declarations for products of the same type by other manufacturers in the same industry.
- G. GreenScreen Chemical Hazard Analysis: Ingredients of 100 parts-per-million or greater evaluated using GreenScreen (METH).
 1. Good: GreenScreen (LIST) evaluation to identify Benchmark 1 hazards; a Health Product Declaration includes this information.
 2. Better: GreenScreen Full Assessment.
 3. Best: GreenScreen Full Assessment by GreenScreen Licensed Profiler.
 4. Acceptable Evidence: GreenScreen report.
- H. Health Product Declarations (HPD): Complete, published declaration with full disclosure of known hazards, prepared using one of the HPDC (HPD-OLT) online tools.
- I. Leadership Extraction Practices: Products that meet at least one of the responsible extraction criteria, which include: extended producer responsibility; bio-based materials; FSC wood products; materials reuse; recycled content; and other programs approved by sustainability certification system used for the project.
- J. Manufacturer's Inventory of Product Content: Publicly available inventory of every ingredient identified by name and Chemical Abstract Service Registration Number (CAS RN).
 1. For ingredients considered a trade secret or intellectual property, the name and CAS RN may be omitted, provided the ingredient's role, amount, and GreenScreen Benchmark are given.

- K. Rapidly Renewable Materials: Made from agricultural products that are typically harvested within a 10-year or shorter cycle.
- L. Regional Materials: Materials that are extracted, harvested, recovered, and manufactured within a radius of 100 miles from the Project site.
- M. Reused Products: Materials and equipment previously used in this or other construction, salvaged and refurbished as specified.
 - 1. Wood fabricated from timber abandoned in transit after harvesting is considered reused, not recycled.
 - 2. Acceptable Evidence: Information about the origin or source, from Contractor or supplier.
- N. Source Location: Location of harvest, extraction, recovery, or manufacture; where information about source location is required to be submitted, give the postal address:
 - 1. In every case, indicate the location of final assembly.
 - 2. For harvested products, indicate location of harvest.
 - 3. For extracted (i.e. mined) products, indicate location of extraction.
 - 4. For recovered products, indicate location of recovery.
 - 5. For products involving multiple manufacturing steps, provide a description of the process at each step, with location.
 - 6. Acceptable Evidence:
 - a. Manufacturer's certification.
 - b. Life cycle analysis (LCA) performed by third-party.
- O. Sustainably Harvested Wood: Solid wood, wood chips, and wood fiber certified or labeled by an organization accredited by one of the following:
 - 1. The Forest Stewardship Council, The Principles for Natural Forest Management; for Canada visit <http://www.fscscanada.org>, for the USA visit <http://www.fscus.org>.
 - 2. Acceptable Evidence: Copies of invoices bearing the certifying organization's certification numbers.

PART 2 PRODUCTS

2.01 EXISTING PRODUCTS

- A. Do not use materials and equipment removed from existing premises unless specifically required or permitted by the Contract Documents.
- B. Existing materials and equipment indicated to be removed, but not to be re-used, relocated, reinstalled, delivered to the Owner, or otherwise indicated as to remain the property of the Owner, become the property of the Contractor; remove from site.

2.02 NEW PRODUCTS

- A. Provide new products unless specifically required or permitted by the Contract Documents.
- B. All new exterior envelope products must be Florida Product Approved. Provide Notice of Acceptance documentation with submittals.
- C. Use of products having any of the following characteristics is not permitted:
 - 1. Made using or containing CFC's or HCFC's.
 - 2. Made of wood from newly cut old growth timber.
 - 3. Containing lead, cadmium, or asbestos.
- D. Where other criteria are met, Contractor shall give preference to products that:
 - 1. If used on interior, have lower emissions, as defined in Section 016116.
 - 2. If wet-applied, have lower VOC content, as defined in Section 016116.
 - 3. Are extracted, harvested, and/or manufactured closer to the location of the project.
 - 4. Have longer documented life span under normal use.
 - 5. Result in less construction waste. See Section 017419
 - 6. Are made of recycled materials.
 - 7. If made of wood, are made of sustainably harvested wood, wood chips, or wood fiber.

8. If bio-based, other than wood, are or are made of Sustainable Agriculture Network certified products.
9. Are Cradle-to-Cradle Certified.
10. Have a published Environmental Product Declaration (EPD).
11. Have a published Health Product Declaration (HPD).

2.03 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.04 MAINTENANCE MATERIALS

- A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.
- B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION LIMITATIONS

- A. See Section 012500 - Substitution Procedures.

3.02 TRANSPORTATION AND HANDLING

- A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.
- B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.
- C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- D. Transport and handle products in accordance with manufacturer's instructions.
- E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
- F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.
- H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.03 STORAGE AND PROTECTION

- A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. See Section 017419.
- B. Store and protect products in accordance with manufacturers' instructions.
- C. Store with seals and labels intact and legible.
- D. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.
- E. For exterior storage of fabricated products, place on sloped supports above ground.
- F. Provide off-site storage and protection when site does not permit on-site storage or protection.
- G. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.

- H. Comply with manufacturer's warranty conditions, if any.
- I. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- J. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- K. Prevent contact with material that may cause corrosion, discoloration, or staining.
- L. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- M. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION 016000

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**SECTION 016116
VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Requirements for Indoor-Emissions-Restricted products.
- B. Requirements for VOC-Content-Restricted products.
- C. Requirement for installer certification that they did not use any non-compliant products.

1.02 RELATED REQUIREMENTS

- A. Section 013000 - Administrative Requirements: Submittal procedures.

1.03 DEFINITIONS

- A. Indoor-Emissions-Restricted Products: All products in the following product categories, whether specified or not:
 - 1. Interior paints and coatings applied on site.
 - 2. Interior adhesives and sealants applied on site, including flooring adhesives.
 - 3. Flooring.
 - 4. Composite wood.
 - 5. Products making up wall and ceiling assemblies.
 - 6. Thermal and acoustical insulation.
 - 7. Free-standing furniture.
 - 8. Other products when specifically stated in the specifications.
- B. VOC-Content-Restricted Products: All products in the following product categories, whether specified or not:
 - 1. Interior paints and coatings applied on site.
 - 2. Interior adhesives and sealants applied on site, including flooring adhesives.
- C. Interior of Building: Anywhere inside the exterior weather barrier.
- D. Adhesives: All gunnable, trowelable, liquid-applied, and aerosol adhesives, whether specified or not; including flooring adhesives, resilient base adhesives, and pipe jointing adhesives.
- E. Sealants: All gunnable, trowelable, and liquid-applied joint sealants and sealant primers, whether specified or not; including firestopping sealants and duct joint sealers.
- F. Inherently Non-Emitting Materials: Products composed wholly of minerals or metals, unless they include organic-based surface coatings, binders, or sealants; and specifically the following:
 - 1. Concrete.
 - 2. Clay brick.
 - 3. Metals that are plated, anodized, or powder-coated.
 - 4. Glass.
 - 5. Ceramics.
 - 6. Solid wood flooring that is unfinished and untreated.

1.04 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency current edition.
- B. ASTM D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings 2005 (Reapproved 2018).
- C. BIFMA e3 - Furniture Sustainability Standard; Business and Institutional Furniture Manufacturers Association 2019.
- D. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions From Indoor Sources Using Environmental Chambers 2017, v1.2.

- E. CARB (ATCM) - Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products; California Air Resources Board current edition.
- F. CARB (SCM) - Suggested Control Measure for Architectural Coatings; California Air Resources Board 2007.
- G. CHPS (HPPD) - High Performance Products Database Current Edition at www.chps.net/.
- H. CRI (GLP) - Green Label Plus Testing Program - Certified Products Current Edition.
- I. SCAQMD 1113 - Architectural Coatings 1977 (Amended 2016).
- J. SCAQMD 1168 - Adhesive and Sealant Applications 1989 (Amended 2017).
- K. SCS (CPD) - SCS Certified Products Current Edition.
- L. UL (GGG) - GREENGUARD Gold Certified Products Current Edition.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: For each VOC-restricted product used in the project, submit evidence of compliance.
- C. Installer Certifications Regarding Prohibited Content: Require each installer of any type of product (not just the products for which VOC restrictions are specified) to certify that either 1) no adhesives, joint sealants, paints, coatings, or composite wood or agrifiber products have been used in the installation of installer's products, or 2) that such products used comply with these requirements.

1.06 QUALITY ASSURANCE

- A. Indoor Emissions Standard and Test Method: CAL (CDPH SM), using Standard Private Office exposure scenario and the allowable concentrations specified in the method, and range of total VOC's after 14 days.
 - 1. Wet-Applied Products: State amount applied in mass per surface area.
 - 2. Paints and Coatings: Test tinted products, not just tinting bases.
 - 3. Evidence of Compliance: Acceptable types of evidence are the following;
 - a. Current UL (GGG) certification.
 - b. Current SCS (CPD) Floorscore certification.
 - c. Current SCS (CPD) Indoor Advantage Gold certification.
 - d. Current listing in CHPS (HPPD) as a low-emitting product.
 - e. Current CRI (GLP) certification.
 - f. Test report showing compliance and stating exposure scenario used.
 - 4. Product data submittal showing VOC content is NOT acceptable evidence.
 - 5. Manufacturer's certification without test report by independent agency is NOT acceptable evidence.
- B. VOC Content Test Method: 40 CFR 59, Subpart D (EPA Method 24), or ASTM D3960, unless otherwise indicated.
 - 1. Evidence of Compliance: Acceptable types of evidence are:
 - a. Report of laboratory testing performed in accordance with requirements.
- C. Composite Wood Emissions Standard: CARB (ATCM) for ultra-low emitting formaldehyde (ULEF) resins.
 - 1. Evidence of Compliance: Acceptable types of evidence are:
 - a. Current SCS "No Added Formaldehyde (NAF)" certification; www.scs-certified.com.
 - b. Report of laboratory testing performed in accordance with requirements.
 - c. Published product data showing compliance with requirements.
- D. Furnishings Emissions Standard and Test Method: BIFMA e3 Sections 7.6.1 and 7.6.2, tested in accordance with BIFMA M7.1.
 - 1. Evidence of Compliance:

- a. Test report showing compliance and stating exposure scenario used.
- E. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All Products: Comply with the most stringent of federal, State, and local requirements, or these specifications.
- B. Indoor-Emissions-Restricted Products: Comply with Indoor Emissions Standard and Test Method, except for:
 - 1. Composite Wood, Wood Fiber, and Wood Chip Products: Comply with Composite Wood Emissions Standard or contain no added formaldehyde resins.
 - 2. Furnishings: Comply with Furnishings Emissions Standard and Test Method.
 - 3. Inherently Non-Emitting Materials.
- C. VOC-Content-Restricted Products: VOC content not greater than required by the following:
 - 1. Adhesives, Including Flooring Adhesives: SCAQMD 1168 Rule.
 - 2. Joint Sealants: SCAQMD 1168 Rule.
 - 3. Paints and Coatings: Each color; most stringent of the following:
 - a. 40 CFR 59, Subpart D.
 - b. SCAQMD 1113 Rule.
 - c. CARB (SCM).

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Owner reserves the right to reject non-compliant products, whether installed or not, and require their removal and replacement with compliant products at no extra cost to Owner.
- B. Additional costs to restore indoor air quality due to installation of non-compliant products will be borne by Contractor.

END OF SECTION 016116

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**SECTION 017000
EXECUTION AND CLOSEOUT REQUIREMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Examination, preparation, and general installation procedures.
- B. Requirements for alterations work, including selective demolition.
- C. Pre-installation meetings.
- D. Cutting and patching.
- E. Cleaning and protection.
- F. Demonstration and instruction of Owner personnel.
- G. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.
- H. General requirements for maintenance service.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
 - 1. Structural integrity of any element of Project.
 - 2. Integrity of weather exposed or moisture resistant element.
 - 3. Efficiency, maintenance, or safety of any operational element.
 - 4. Visual qualities of sight exposed elements.
 - 5. Work of Owner or separate Contractor.
- C. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.04 PROJECT CONDITIONS

- A. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- B. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.
 - 1. Provide dust-proof barriers between construction areas and areas continuing to be occupied by Owner.
- C. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.
 - 1. Indoors: Limit conduct of especially noisy interior work to the hours of 6 pm to 7 am.
- D. Pest and Rodent Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.
- E. Rodent Control: Provide methods, means, and facilities to prevent rodents from accessing or invading premises.

1.05 COORDINATION

- A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. Notify affected utility companies and comply with their requirements.

- C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- D. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on drawings. Follow routing indicated for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- F. Coordinate completion and clean-up of work of separate sections.
- G. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
- C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 016000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
- E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
- F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 PREINSTALLATION MEETINGS

- A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.
- B. Require attendance of parties directly affecting, or affected by, work of the specific section.
- C. Notify Architect four days in advance of meeting date.

- D. Prepare agenda and preside at meeting:
 - 1. Review conditions of examination, preparation and installation procedures.
 - 2. Review coordination with related work.
- E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.04 GENERAL INSTALLATION REQUIREMENTS

- A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
- B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.05 ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of alterations work constitutes acceptance of existing conditions.
- B. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
 - 2. Remove items indicated on drawings.
 - 3. Relocate items indicated on drawings.
 - 4. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
 - 5. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.
- C. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove, relocate, and extend existing systems to accommodate new construction.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
 - 2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.
 - 3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - a. Disable existing systems only to make switchovers and connections; minimize duration of outages.
 - b. Provide temporary connections as required to maintain existing systems in service.
 - 4. Verify that abandoned services serve only abandoned facilities.
 - 5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.
- D. Protect existing work to remain.

1. Prevent movement of structure; provide shoring and bracing if necessary.
 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 3. Repair adjacent construction and finishes damaged during removal work.
- E. Adapt existing work to fit new work: Make as neat and smooth transition as possible.
1. When existing finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Architect.
 2. Where removal of partitions or walls results in adjacent spaces becoming one, rework floors, walls, and ceilings to a smooth plane without breaks, steps, or bulkheads.
 3. Where a change of plane of 1/4 inch or more occurs in existing work, submit recommendation for providing a smooth transition for Architect review and request instructions.
 4. Trim existing wood doors as necessary to clear new floor finish. Refinish trim as required.
- F. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.
- G. Refinish existing surfaces as indicated:
1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
 2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.
- H. Clean existing systems and equipment.
- I. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.
- J. Do not begin new construction in alterations areas before demolition is complete.
- K. Comply with all other applicable requirements of this section.

3.06 CUTTING AND PATCHING

- A. Whenever possible, execute the work by methods that avoid cutting or patching.
- B. See Alterations article above for additional requirements.
- C. Perform whatever cutting and patching is necessary to:
1. Complete the work.
 2. Fit products together to integrate with other work.
 3. Provide openings for penetration of mechanical, electrical, and other services.
 4. Match work that has been cut to adjacent work.
 5. Repair areas adjacent to cuts to required condition.
 6. Repair new work damaged by subsequent work.
 7. Remove samples of installed work for testing when requested.
 8. Remove and replace defective and non-complying work.
- D. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- E. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- G. Restore work with new products in accordance with requirements of Contract Documents.
- H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

- I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 078400, to full thickness of the penetrated element.
- J. Patching:
 - 1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
 - 2. Match color, texture, and appearance.
 - 3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.07 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.08 PROTECTION OF INSTALLED WORK

- A. Protect installed work from damage by construction operations.
- B. Provide special protection where specified in individual specification sections.
- C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- G. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.09 DEMONSTRATION AND INSTRUCTION

- A. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at equipment location.
- B. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- C. Provide a qualified person who is knowledgeable about the Project to perform demonstration and instruction of Owner's personnel.

3.10 ADJUSTING

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

3.11 FINAL CLEANING

- A. Use cleaning materials that are nonhazardous.
- B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.

- C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
- D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- E. Clean filters of operating equipment.
- F. Clean debris from roofs, gutters, downspouts, scuppers, overflow drains, area drains, drainage systems, and [_____].
- G. Clean site; sweep paved areas, rake clean landscaped surfaces.
- H. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.12 CLOSEOUT PROCEDURES

- A. Make submittals that are required by governing or other authorities.
 - 1. Provide copies to Architect and Owner.
- B. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.
- C. Notify Architect when work is considered ready for Architect's Substantial Completion inspection.
- D. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's Substantial Completion inspection.
- E. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect.
- F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.
- G. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.
- H. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

3.13 MAINTENANCE

- A. Provide service and maintenance of components indicated in specification sections.
- B. Maintenance Period: As indicated in specification sections or, if not indicated, not less than one year from the Date of Substantial Completion or the length of the specified warranty, whichever is longer.
- C. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- D. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.
- E. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

END OF SECTION 017000

**SECTION 01 9113
GENERAL COMMISSIONING REQUIREMENTS**

PART 1 - GENERAL

1.01 SUMMARY

- A. This section includes the general requirements that apply to the implementation of the commissioning process for this project. Commissioning (Cx) is a quality oriented process for achieving, verifying, and documenting that the performance of the facilities, systems and assemblies meet defined objectives and criteria.
- B. The commissioning process does not limit the responsibilities of the Contractor or the Design teams to provide a fully functional facility.
- C. Related Sections
 - 1. Division 23 Heating, Ventilation, and Air Conditioning (HVAC)
 - 2. Division 26 Electrical

1.02 REFERENCE

- A. Florida Building Code 2020
- B. ASHRAE Standard 202-2013

1.03 DESCRIPTION

- A. Installations are observed at various stages of construction and systems are functionally tested under various conditions, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, safety modes, power failure, etc.
- B. Components are verified and documented to be installed and responding in accordance with Owner requirements and contract documents.
- C. Functional tests are executed after installation verification checklists and start-ups are complete.
- D. The Commissioning plan describes the commissioning roles and responsibilities for the team. They include:
 - 1. Commissioning Team:
 - a. Participate in the Cx process.
 - b. Attend Cx kick-off meeting and other Cx Team meetings.
 - 2. Cx Authority
 - a. Direct the Cx process
 - b. Provide Cx Plan, Cx Checklist, Functional Performance Tests (FPT), action item list and final Cx report.
 - c. Lead the Cx Team meetings
 - d. Assist with the development of the Cx schedule.
 - e. Perform field visits and document installation
 - 3. Contractor:
 - a. Attend Cx kick-off meeting and other Cx Team meetings
 - b. Include requirements for Cx activities in each subcontract.
 - c. Facilitate coordination of Cx activities.
 - d. Manage Cx communication with sub-contractors.
 - e. Incorporate Cx activities and milestones into master construction schedule. Coordinate with CxA.
 - f. Manage the completion, submission, and review of Checklist and other documentation. Forward completed checklist to CxA at least 10 workdays prior to the scheduled testing date.
 - g. Ensure corrective actions are taken for deficiencies, punchlist, and other identified actionable items.
 - h. Document responses and corrective actions for Cx action items and punchlist.
 - i. Provide CxA with required documentation from Cx activities and submittal request.

- j. Incorporate durations into construction schedule per each system completion to administer FPT.
 - k. Submit detailed training plan to A/E for approval and CxA for comment.
 - l. Schedule, coordinate and assist CxA in seasonal or deferred testing and deficiency corrections required by specifications.
 - m. Provide upon request, documentation such as manufacturer and model number, manufacturer's printed installation and detailed start-up procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings, and details of Owner contracted tests.
4. Sub-contractors:
- a. Attend Cx kick-off meeting and other Cx Team meetings
 - b. Assist with the development of the Cx schedule.
 - c. Complete and sign Cx Checklist in cooperation with the Contractor and submit with supporting documentation. Provide individuals or manufacturer's representatives with specific knowledge of completion of work.
 - d. Ensure installation work is complete, is in compliance with Contract Documents, Checklist are complete and systems are ready for functional testing.
 - e. Provide certified and calibrated instrumentation required to take measurements of system and equipment performance during functional testing.
 - f. Execute inspections, tests, and functional testing as described in contract documents and Cx Plan. Demonstrate and manipulate systems and equipment to show proper operation.
 - g. Provide documents such as trending, calibrations, testing, history, start-up, flushing, installation, etc. as needed for CxA review and documentation.
- E. HVAC systems to be commissioned:
- 1. Air Handling Units
 - 2. Air Terminals
 - 3. Exhaust
 - 4. Building Automation
 - 5. Lab Controls
 - 6. Heating Hot Water
 - 7. Misc. HVAC
- F. Electrical Systems to be commissioned
- 1. Lighting
 - 2. Lighting Control Systems

1.04 DEFINITIONS

- A. Acceptance Phase – Phase during which system functionality is demonstrated by the installer and documented by the Cx Authority.
- B. BOD - Basis of Design documents the design criteria and decisions made to meet design intent. Describes systems, components, conditions, and methods chosen to define the intent of the Owner.
- C. BAS – Building Automation System
- D. Building Envelope: The assembly of floor, wall/skin, and roof system components that are designed and intended to reduce the transfer of thermal energy and water vapor and to help eliminate water intrusion.
- E. Construction Phase – Installation of systems prior to functional testing.
- F. Commissioning (Cx) Process – A quality focused process for enhancing the delivery of a project. The process includes focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated and maintained to meet the Owner's Project Requirements.

- G. CxA - Cx Authority is the consultant who facilitates the Cx program and directs and coordinates day-to-day Cx activities. .
- H. Cx Plan - A manual providing documentation of roles and responsibilities and provides structured means of scheduling, coordination and documentation for the Cx process.
- I. Cx Team – The Cx A, Contractor, sub-contractor, and Owner.
- J. Deficiency: Condition of a component, piece of equipment, or system that is not in compliance with Contract Documents.
- K. FPT - Functional Performance Tests documents the dynamic function and operation of equipment and systems.
- L. Issues Log – Items or issued identified by CxA (or other Owner reps) during construction that require contractor response. The primary role of the issues log is to track resolution or closure of deficiencies, recommendations, documentation, etc..
- M. OPR – Owner’s Project Requirements documents the project expectations of the Owner.
- N. Cx Checklist – (also known as “pre-functional checklist or PFC’s) is the list of items to inspect and elementary component tests that verify proper installation of equipment. The primary purpose of the Cx Checklist is to document static conditions and procedures prior to initial operation (e.g., belt tension, oil levels, labels affixed, gages in place, sensors calibrated, programming complete, etc.). It is a coordinated document representing the efforts of the various installing subcontractors.
- O. Start-up Plan – An organized plan to ensure systems and equipment are started and maintained properly during construction phase activities.
- P. Systems Manual – An Owner focused document for operating and maintaining the commissioned systems throughout the life of the facility. The Systems Manual is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references. The Systems manual is organized by “systems” not by specifications and includes design, operation, maintenance parameters, Cx test, etc.
- Q. TAB – Test, Adjust and Balance.
- R. Training Plan – a documented, structured approach to Owner training.
- S. Trending: Monitoring and recording controls points of systems as a function of time using building automation system.
- T. Warranty Phase – Post construction. (typically for one year)

1.05 SUBMITTALS

- A. Start up and TAB Plan:
 - 1. Planned delivery dates for major material and equipment, and expected lead times
 - 2. Milestones indicating possible restraints on work by other trades or situations
 - 3. Start dates of individual work items
 - 4. Duration of individual work items
 - 5. Workflow process to start equipment
 - 6. Startup procedures including flushing, filtering, pre-testing, etc.
 - 7. Indoor Air Quality Control
 - 8. Trade coordination required to minimize dust
 - 9. Provide vendor specific start up documentation
 - 10. Coordination of equipment controlled and monitored
 - 11. Temporary controls
 - 12. TAB phasing
- B. Completed Cx Checklist
 - 1. Submit an executed Cx Checklist for each piece of equipment/system to be commissioned.
 - 2. Transmit completed Cx Checklist to the CxA to document request for functional testing to begin.
- C. HVAC Controls Manual

1. Organize manual by systems and submit in original electronic format (scanned documentation is not allowed)
 2. Include a table of contents, bookmarks and the following information:
 - a. Maintenance and calibration
 - b. Narrative of operations for each system
 - c. As-built wiring diagrams
 - d. As-built sequence of operations & setpoints
 - e. Scheduling & Programing instructions
 - f. TAB Report
 - g. Final Commissioning Process Report
- D. Training Plan
1. Organized list of specific equipment or systems that require training
 2. Separate agenda for each training session including but be not limited to:
 - a. Construction Document review of systems
 - b. Installation and as-built conditions
 - c. Theory of operation
 - d. Demonstration of operation
 - e. Operation and Maintenance Document
 - f. Servicing and Maintenance Schedules
 - g. Interlocks and Safeties
 3. Manufactures recommended classroom training and schedule

1.06 QUALITY ASSURANCE

- A. Review the Cx Plan the plan for responsibilities and expectations during the Cx process.
- B. Support the commissioning process to ensure quality installation, operation and maintenance.
- C. During Construction and Acceptance Phase:
 1. Coordinate Cx activities with the Cx Team
 2. Confirm equipment installation and start up is completed prior to functional testing.
 3. Ensure Cx Checklist are completed prior to functional testing
 4. Demonstrate FPT with, and to the satisfaction of CxA.
 5. Manage and correct issues identified by CxA
 6. Performs FPT retests as needed to verify correction of any deficiencies

1.07 SYSTEM STARTUP

- A. Start equipment according to manufactures recommendation.
- B. Document system start up time and date.
- C. Document person(s) performing startup.
- D. Protect equipment from construction dust & debris.

1.08 SCHEDULING

- A. Coordinate and communicate commissioning activities with Owner, and CxA. Commissioning milestones include, but are not limited to:
 1. **[RESERVED]**
- B. Coordinate and communicate other activities such as inspections, meetings, and schedule changes to the CxA.
- C. Ensure commissioning activities are incorporated into project schedule. Coordinate with CxA.

1.09 WARRANTY

- A. During warranty phase, a review of building performance as well as seasonal testing shall occur. Provide appropriate personnel for opposite seasonal testing and warranty phase inspections.
- B. Repair, replace and correct, to the satisfaction of the Owner, any commissioning action items found during warranty period.

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

- A. Provide all specialized tools, test equipment, and instruments required to execute startup, checkout, and FPT of systems and equipment being commissioned.
- B. Test equipment shall be of sufficient quality and accuracy to test and/or measure system performance according to specified tolerances and have calibrated per the respective specifications.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Review commissioning documentation including Cx Plan, Pre-functional Checks, and Functional Performance Test.
- B. Prior to start of any work, check, verify, and coordinate work with Cx Plan, drawings, manufactures recommended installation/start-up, and specifications.
- C. Promptly request clarification and instruction or report any conflicts, inadequate conditions or missing information in the Cx documents.
- D. Respond to action items and field reports as noted by CxA. Provide action taken or solutions to each item.

3.02 FIELD QUALITY CONTROL

- A. Cx Checklist:
 - 1. Complete Cx Checklist to document systems are installed according to contract documents and manufactures recommendations.
 - 2. Conduct a complete performance test for all systems to assure compliance with the contract documents.
 - a. Any components on systems found defective or not performing satisfactorily shall be readjusted and retested after necessary corrective measures are performed.
 - b. Corrective measures may include modification or addition of equipment and devices, control strategies and/or software program.
 - 3. Submit Cx Checklist prior to formal demonstration of FPT.
 - 4. Schedule demonstration of FPT with Cx at least 10 days in advanced.
- B. Repair, reprogram or replace any equipment or work that fails test.
- C. Respond to, and take corrective action on deficiency items or non-conformance issues noted and reported to Cx team as an action list or punch list item. Include:
 - 1. The corrective action taken to remedy issue
 - 2. The date the corrective action was taken
 - 3. Initials, or name of person responding to the issue
 - 4. RFI number if applicable
- D. Notify and coordinate with CxA, observation of field test such as duct pressure test, pipe pressure testing, flushing, balancing, etc.

3.03 DEMONSTRATION

- A. Coordinate FPT activities.
- B. Provide competent person (vendor or manufactures representative) to demonstrate functional performance of each system being commissioned.
- C. Utilizing CxA provided FPT, demonstrate to the CxA, the operation of each system being commissioned.
 - 1. Take actions as needed, to expedite testing and minimize unnecessary delays, while not compromising integrity of procedures.
 - 2. Post date for completion of resolution of deficiency.
- D. Coordination and Scheduling:
 - 1. Integrate Cx activities into the project construction schedule. Include milestone deadlines for completion of Cx Checklist and durations for FPT of each system.

2. CxA will witness and document FPT of systems which as demonstrated by the Contractor or its sub contractor. Designated sub-contractor or vendor responsible for dynamic operation of a system or device shall demonstrate system functionality to CxA.
- E. Manage the resolution of discrepancies, punch-list, action items, etc. identified during the Cx process.

END OF SECTION

SECTION 031000

CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes, but is not limited to, the design, engineering, construction and removal of formwork required for cast-in-place concrete as shown on the drawings and specified herein.
- B. Related Sections include, but are not limited to, the following:
 - 1. Section 033000 "Cast-In-Place Concrete" for finishes.
- C. Work Installed and Furnished by Others:
 - 1. Install built-in anchors, inserts, and bolts for connection of other materials; sleeves, thimbles, and dovetail anchor slots, plates, frames, seats and all other embedded items including Owner furnished items.
 - 2. Coating of forms and other surfaces as required by this Section.

1.3 DEFINITIONS

- A. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4 ACTION SUBMITTALS

- A. Product Data: Submit, for record only, not for approval, data for each type of product and material indicated including others as requested by Architect. Substitutions for specified items or manufacturers are to be submitted in accordance with Section 1 and will be subject to approval, rejection or other appropriate action.
- B. Formwork Shop Drawings: Prepare shop drawings in compliance with ACI 301 and ACI 347R. If requested by the Architect, submit shop drawings showing general construction of forms for concrete permanently exposed to view; including jointing, special form joints or reveals, location and pattern of form tie placement, and other items that visually affect exposed concrete. Architect's review is for general architectural applications and features only. Formwork design for safety, structural adequacy and efficiency is Contractor's responsibility.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For the form-release agent, signed by manufacturer.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Delegated Engineer Qualifications: A licensed engineer who is legally qualified to practice in the State of Florida and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for formwork and shoring and reshoring installations that are similar to those indicated for this Project in material, design, and extent.
- C. Codes and Standards: Comply with the following, unless more stringent provisions are indicated:
 - 1. Florida Building Code, 7th Edition.
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 - 3. ACI 301, "Specifications for Structural Concrete."
 - 4. ACI-318, "Building Code Requirements for Structural Concrete and Commentary."
 - 5. ACI 347, "Guide to Formwork for Concrete."
 - 6. ACI SP-4, "Formwork for Concrete."
 - 7. American Forest and Paper Association, "National Design Specifications for Wood Construction."
 - 8. American Plywood Association (APA), "Plywood Design Specification" (Form Y-510); "Concrete Forming: (Form V345)
 - 9. National Institute of Standards and Technology (NIST), "Voluntary Product Standard PS 1-07 for Construction and Industrial Plywood" (Form V995).

1.7 JOB CONDITIONS AND COORDINATION OF TRADES

- A. General: It is the Contractor's sole responsibility to coordinate with all trades for the setting of sleeves, anchor bolts, dovetail slots, inserts, frames, flashing, reglets, pipes, ducts and other embedded items and provide all openings required for installation of other work in accordance with the Contractor's shop drawings and the Contract Documents.
- B. Structural Integrity: Provide no sleeves or openings in structural members unless shown on the structural drawings or approved by the Architect.
- C. Inspection: Architect may inspect formwork at any time and may reject formwork if forms do not conform to the lines, levels, and tolerances as required in this Section, the shop drawings or the Design Drawings. If formwork is rejected, the Contractor must repair or replace the rejected portion with no additional cost to the Owner.

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. APA Medium-density overlay, Class 1 or better; mill-release agent treated 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. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide paper or fiber tubes of laminated plies with water resistant adhesive and wax impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Stable Soil: In the event stable soil is encountered and straight-line embankments can be maintained, concrete foundations may be placed into accurately excavated earth trenches, free from water, debris, or loose dirt. Excavations shall be minimum 2" wider and longer than specified.

2.2 RELATED MATERIALS

- A. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- B. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- C. 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.
- D. 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 inch to the plane of the exposed concrete surface.
 2. Furnish ties that, when removed, will leave holes not larger than 1 inch in diameter in concrete surface.
- E. Accessories: Provide necessary anchors, form ties, shores, construction joints, scaffolds, and bracing as required to install forms. Provide construction joints, control joints, expansion joints and waterstops where indicated on the drawings.
1. Form Joint Gasket: Closed cell rubber sponge. Take care that form joints are sealed from leakage of cement paste and moisture.
 2. Material to form drips, reveals, rustification strips or weep holes shall be extruded plastic.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301 and ACI 347, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete 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.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - 1. Surface Finish-1.0: ACI 117 Class D, 1 inch for permanently concealed rough-formed finished surfaces.
 - 2. ACI 117 Class C, 1/2 inch: Other rough-formed finished surfaces.
 - 3. Surface Finish-2.0: ACI 117 Class B, 1/4 inch for rough-formed finished surfaces intended to receive plaster.
 - 4. Surface Finish-3.0: ACI 117 Class A, 1/8 inch for smooth-formed finish surfaces exposed to public view.
- D. Construct forms tight enough to prevent loss of concrete mortar.
 - 1. Minimize joints.
 - 2. Exposed Concrete: Symmetrically align joints in forms.
- 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. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
- F. Do not use rust-stained steel form-facing material.
- G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- H. 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.
- I. Chamfer exterior corners and edges of permanently exposed concrete.
- J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.
- K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- L. Construction and Movement Joints:
 - 1. Construct joints true to line with faces perpendicular to surface plane of concrete.
 - 2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 3. Place joints perpendicular to main reinforcement.
 - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

5. Space vertical joints in walls as indicated on Drawings.
 - a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
- M. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- N. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- O. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. 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.
 2. Install dovetail anchor slots in concrete structures as indicated.

3.3 EARTH FORMS

- A. Hand trim sides and bottom of earth forms. Remove loose soil and rocks and compact to specified density prior to placing reinforcing or concrete. Moisten sides and bottom immediately prior to concrete placement. Comply with OSHA's "Trench Safety Act".

3.4 REMOVING AND REUSING FORMS

- A. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 degrees F for 24 hours after placing concrete provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are 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. The Architect's approval is required for reusing forms for exposed surfaces. Apply new form-release agent.
- C. Reuse forms to greatest extent possible without damaging structural integrity of concrete and without damaging aesthetics of exposed concrete. 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.

END OF SECTION 031000

SECTION 032000
CONCRETE REINFORCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes, but is not limited to, concrete reinforcement bars, welded-wire reinforcing and necessary accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: Submit, for record only, not for approval, data for each type of product and material indicated including others as requested by Architect. Indicate manufacturing process used for steel reinforcing. Substitutions for specified items or manufacturers are to be submitted in accordance with Division 1 and will be subject to approval, rejection or other appropriate action.
- B. Steel Reinforcement Shop Drawings: Complete details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement" and ACI SP-66 "Detailing Manual". Include bar sizes, length, material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports of concrete reinforcement.
 - 1. Do not reproduce Structural Drawings for use as shop or placement drawings without prior approval of the Architect.
- C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
 - 1. Location of construction joints is subject to approval of the Architect.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
 - 1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4.
- B. Material Certificates: Signed by manufacturers and contractor certifying that the steel reinforcement and reinforcement accessories comply with requirements of the Contract Documents. Unidentifiable steel is prohibited.

- C. Material Test Reports: For the following, from a qualified testing agency:
 - 1. Steel Reinforcement:
 - a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706.
 - 2. Mechanical splice couplers.

1.5 QUALITY ASSURANCE

- A. Codes and Standards: Comply with the following, unless more stringent provisions are indicated:
 - 1. Florida Building Code, 7th Edition.
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 - 3. ACI 301, "Specifications for Structural Concrete."
 - 4. ACI 315, "Details and Detailing of Concrete Reinforcement."
 - 5. ACI-318, "Building Code Requirements for Structural Concrete and Commentary."
 - 6. "CRSI Manual of Standard Practice."
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4.
- C. Installer Qualifications: An experienced installer who has completed concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle steel reinforcement to prevent bending and damage and to avoid damaging coatings on steel reinforcement.
 - 1. Deliver reinforcement to the job site bundled, tagged and marked. Use durable metal or embossed plastic tags indicating bar size, lengths, and reference information corresponding to markings shown on placement drawings. Do not store reinforcement in contact with earth.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615, Grade 60, deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A706, deformed.
- C. Headed-Steel Reinforcing Bars: ASTM A970.
- D. Plain-Steel Welded-Wire Reinforcement: ASTM A1064, plain, fabricated from as-drawn steel wire into flat sheets. Rolls are not acceptable.

2.2 REINFORCEMENT ACCESSORIES

- A. 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 where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless-steel bar supports.
 2. For welded wire fabric in slabs on grade use precast slab bolsters, concrete brick or sand plate chairs spaced no farther than 3'-0" c/c.
- B. Mechanical Splices for Reinforcing Steel: Reinforcing bar splicing system designed to develop minimum 1.25 Fy of the reinforcing bars in both tension and compressions, conforming to ACI 318. Splicing system shall be listed by the International Code Council (ICC). Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to, the following:
1. Screw-lock bar coupling sleeve system.
 - a. Dayton Superior Bar Lock Coupling System.
 - b. Erico Lenton Lock Mechanical Rebar System.
- C. Reinforcing Dowel Replacement: Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to, the following:
1. Dayton Superior Taper-Lock Form Saver.
 2. Erico Lenton Form Saver.
- D. Steel Tie Wire: ASTM A1064, annealed steel, not less than 00508 inch in diameter.

2.3 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."
- B. Shop bend and fabricate reinforcing bars to conform with shapes and dimensions indicated on drawings. In case of errors, do not bend or straighten reinforcement without prior approval of Structural Engineer. Make all bends cold.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protection of In-Place Conditions:
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 reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover specified on the drawings. Do not tack weld crossing reinforcing bars.
- C. Preserve clearance between bars of not less than 1", not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with ACI 318.
- E. Tie bars and bar supports together with 16-gauge wire and set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
 - 1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than 48 bar diameters at splices, or 24 inches, whichever is greater.
 - 2. Stagger splices in accordance with ACI 318.
 - 3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
 - 4. Weld reinforcing bars in accordance with AWS D1.4, where indicated on Drawings.
- G. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging (3'-0" o.c. max.). Lap edges and ends of adjoining sheets at least two mesh spacings. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with 16-gauge wire.
- H. Splices: Locate only where indicated on the drawings or approved shop drawings except with prior approval of Engineer.
 - 1. For standard splices, lap ends, placing bars in contact, and tightly wire tie. See drawings for lap lengths.
 - 2. Install mechanical splicing components in accordance with manufacturer's instructions.
 - 3. Do not weld splices.
- I. Provide template for all column dowels.
- J. Do not bend bars embedded in hardened or partially hardened concrete without approval from the Structural Engineer.
- K. Do not weld reinforcing bars unless specifically shown. Where shown comply with AWS D1.4. Bars to be welded shall conform to ASTM A706.

3.3 JOINTS

- A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement.
 - 2. Continue reinforcement across construction joints unless otherwise indicated.
 - 3. Do not continue reinforcement through sides of strip placements of floors and slabs.

3.4 INSTALLATION TOLERANCES

- A. Comply with ACI 117.

END OF SECTION 032000

SECTION 033000

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes, but is not necessarily limited to, concrete, concrete materials, mix design, placement procedures, curing and finishes.
- B. Related Sections include, but are not necessarily limited to, the following:
 - 1. Section 031000 "Concrete Forming and Accessories".
 - 2. Section 032000 "Concrete Reinforcing."
 - 3. Section 312000 "Earthmoving" for drainage fill under slabs-on-grade, including grade beams and pile caps.

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

- A. Product Data: Submit, for record only, not for approval, data for each type of product and material indicated including admixtures, patching compounds, waterstops, joint systems, curing compounds, and others as requested by Architect.
- B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments. Substantiating data to be no older than one year from date of submittal for each mix design.
 - 1. Indicate amounts of mix water to be withheld for later addition at Project site.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For the following:
 - 1. Installer:

- a. ACI Flatwork Technician certifications.
 - b. Written evidence that flatwork placer/finisher has not less than (3) years continuous experience and a minimum of (5) projects in the successful placement and finishing of concrete slabs with flatness and levelness requirements equal to or higher than those specified for this project.
 - c. Written evidence of 10 projects that Installer has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
2. Ready-Mixed Concrete Manufacturer: NRMCA's "Certification of Ready Mixed Concrete Production Facilities".
- B. Material Certificates: Signed by manufacturers and contractor certifying that each of the following items complies with requirements of the Contract Documents:
1. Cementitious materials and aggregates.
 2. Admixtures.
 3. Floor and slab treatments.
 4. Waterstops.
 5. Curing materials.
 6. Bonding agents.
 7. Adhesives.
 8. Vapor retarders.
 9. Repair materials.
 10. Epoxy joint filler.
 11. Joint filler strips.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An qualified installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance. Installer shall employ on Project personnel qualified as ACI Flatwork Technician and Finisher and a supervisor who is an ACI Concrete Flatwork Technician.
- B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in the successful manufacturing ready-mixed concrete products complying with ASTM C94 requirements for production and delivery, facilities and equipment.
1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's "Certification of Ready Mixed Concrete Production Facilities".
 2. Manufacturer must be F.D.O.T. certified.
- C. Codes and Standards: Comply with the following, unless modified by requirements in the Contract Documents:
1. Florida Building Code, 7th Edition.
 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 3. ACI 211.1 "Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete."
 4. ACI 301, "Specification for Structural Concrete for Buildings."
 5. ACI-304, "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete."
 6. ACI-305.1, "Guide to Hot Weather Concreting."
 7. ACI-306.1, "Guide to Cold Weather Concreting."

8. ACI-308, "Guide to External Curing of Concrete."
9. ACI-309, "Guide for Consolidation of Concrete."
10. ACI-311.4, "Guide for Concrete Inspection."
11. ACI-318, "Building Code Requirements for Reinforced Concrete."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASTM C94 and ACI 301.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

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

2.2 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 2. Products: Subject to compliance with requirements, provide one of the products specified.
 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.3 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 Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 1. Portland Cement:

- a. ASTM C150, Type I/II
 - b. Slabs on Grade: Type I or Type II with a C3A content less than 8%.
- C. Pozzolans:
1. Fly Ash: ASTM C618, Class **C** or **F**.
- D. Normal-Weight Aggregate: 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.
1. Fine Aggregate: Natural quartz sand or manufactured sand from local stone aggregates conforming to ASTM C33, produced from F.D.O.T. approved sources, with fineness modulus not less than 2.4, and having a proven service record.
 2. Coarse Aggregate: Clean, washed, sound, crushed natural stone products produced from F.D.O.T. approved sources. Free from salt, clay, mud, loam or other foreign matter. Conform to ASTM C33; sizes No. 67 (3/4 inch) or No. 57 (1 inch), No. 8 or No. 89 (3/8 inch), and No. 467 (1 1/2 inch). Use largest size practical for members being cast.
 - a. Class: Negligible weathering region, class per ASTM C33. [1N]
- E. Water: Potable and complying with ASTM C94.

2.4 CONCRETE ADMIXTURES

- A. General: Provide admixtures produced by acceptable manufacturers and used in compliance with the manufacturer's printed directions. Use only admixtures which have been incorporated and tested in the accepted mixes, unless otherwise authorized in writing by the Architect. Do not use admixtures which increase the shrinkage properties of concrete. Submit substantiating data, if requested.
- B. Air-Entraining Admixture: ASTM C260.
- C. Water-reducing admixture: Conform to ASTM C494, Type A, D or E free of chlorides, fluorides, or nitrates, except for those attributable to the water used in manufacturing. Use in all structural concrete.
- D. High Range Water Reducing Admixture: Conform to ASTM C494, Type F or Type G and ASTM C1017, Type I or II. Formulate HRWR based on polycarboxylate technology. The admixture is to be added to the concrete mix after initial mixing has taken place. If added at the batch plant HRWR to have an effective life without redosing (third generation HRWR) of at least 2 Hours. If added at the jobsite, the addition shall be by certified technicians employed by the concrete supplier or an authorized representative of the admixture manufacturer. This admixture is in addition to and not a substitute for any other admixtures specified elsewhere.
- E. Calcium Chloride: Do not use calcium chloride in concrete. Do not use any admixtures which contribute free chloride ions to the concrete mix.

2.5 WATERSTOPS

- A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers for adhesive bonding to concrete.
1. Available Products:

- a. Volclay Waterstop-RX; Colloid Environmental Technologies Co.

2.6 VAPOR RETARDERS

- A. Sheet Vapor Retarder, Class A: ASTM E1745: Include manufacturer's recommended adhesive or pressure-sensitive tape.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Fortifiber Building Systems Group; Moistop Ultra **10**.
 - b. ISI Building Products; Viper VaporCheck II **10**mil.
 - c. Raven Industries Inc.; VaporBlock **VB10**.
 - d. Reef Industries, Inc.; Griffolyn **10** Mil.
 - e. Stego Industries, LLC; Stego Wrap Vapor Barrier (15-Mil)
 - f. W.R. Meadows, Inc.; Perminator **10** mil.

2.7 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Corporation; MasterKure ER 50.
 - b. Euclid Chemical Company (The); an RPM company; Eucobar.
 - c. Laticrete International, Inc.; L&M E-Con.
 - d. Nox-Crete Products Group; Monofilm.
 - e. SpecChem, LLC; Spec Film.
- B. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, (or Type 2) Class B, dissipating. The film must chemically break down in a 4 to 6 week period after application.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Anti-Hydro International, Inc; A-H Curing Compound #2 DR WB.
 - b. ChemMasters, Inc; Safe-Cure Clear DR.
 - c. Euclid Chemical Company (The) an RPM company; Kurez DR VOX.
 - d. Lambert Corporation; AQUA KURE - CLEAR.
 - e. Laticrete International, Inc.; L&M CURE R.
 - f. TK Products; DC WB Dissipating Cure 2519.
 - g. W.R. Meadows, Inc; 1100-CLEAR.
- C. Liquid Membrane-Forming Cure and Seal Compound: VOC Compliant, conforming to ASTM C309, Type 1, Class B and ASTM C1315, Type 1, Class A or B. The compound shall be a clear styrene acrylate type, 25% solids content minimum, and have test data from an independent testing laboratory indicating to a maximum moisture loss of .040 grams per square cm. When applied at a coverage rate of 200 sq. ft. per gallon.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ChemMasters, Inc; Polyseal WB.

- b. Euclid Chemical Company (The); an RPM company; Super Diamond Clear VOX.
 - c. Kaufman Products, Inc; Krystal 25 Emulsion.
 - d. Lambert Corporation; Crystal Clear Seal 1315 WB.
 - e. Laticrete International, Inc.; L&M Dress & Seal WB 25.
 - f. Metalcrete Industries; Metcure 30.
 - g. Nox-Crete Products Group; Cure & Seal 250E.
 - h. Right Pointe; Right Sheen WB30.
 - i. SpecChem, LLC; Cure & Seal WB 25.
 - j. TK Products; TK-Bright Kure & Seal 1315 VOC.
 - k. Vexcon Chemicals Inc.; StarSeal 1315.
 - l. W.R. Meadows, Inc; Vocomp-30.
- D. Absorptive Cover: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- E. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- F. Water: Potable or complying with ASTM C1602.

2.8 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy-Bonding Adhesive: ASTM C881, two-component, 100% solid, epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements. Use Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- D. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.9 CEMENT GROUT AND DRYPACK

- A. Prepackaged Non-Shrink Non-Metallic Non-Gaseous Grout: ASTM C1107, Grade B or C at a fluid consistency (flow cone) of 20 to 30 seconds. Grout shall be bleed free and attain 7500 psi compressive strength in 28 days at fluid consistency. Use for structural repairs.
1. Products: Subject to compliance with requirements, provide one of the following:
- a. BASF Corporation; Masterflow 928.
 - b. Euclid Chemical Company (The) an RPM company; NS Grout.
 - c. Five Star Products, Inc.; Fluid Grout 100.
 - d. Fosroc; Conbextra HF.
 - e. Lambert Corporation; Vibropruf #11.
 - f. Laticrete International, Inc; L&M Crystex.
 - g. Sika Corporation; Sikagrout 212.

- B. Cement Grout: Mix one part Portland cement, 2-1/2 parts fine aggregate, and enough water and liquid bonding agent in a 50/50 mix for required consistency depending on use. Consistency may range from mortar consistency to a mixture that will flow under its own weight. Use for leveling, preparing setting pads of beds, for filling non-structural voids, and similar uses. Do not use for grouting under bearing plates or structural members in place.
- C. Drypack: Mix one part Portland cement, 2 parts fine aggregate, and enough water and liquid bonding agent in a 50/50 mix to hydrate cement and provide a mixture that can be molded with hands into a stable ball (a stiff mix). Do not mix more than can be used in 30 minutes. Use for patching tie holes and large surface defects in concrete.

2.10 SLAB 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, 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 according to ASTM C109.
- B. Repair Topping: Traffic-bearing, 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. For use on slabs not receiving finishes.
 - 1. Cement Binder: ASTM C150, 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 according to ASTM C109.

2.11 CONCRETE MIXTURES

- A. Concrete for all parts of the concrete work shall be homogenous, and when hardened, possess the required strength, durability, water tightness, appearance, resistance to deterioration and abrasion, and other qualities as specified or required.
- B. Mix proportioning: Proportion concrete according to ACI 211.1. Trial mixes shall be designed by the testing laboratory approved by Architect or designed by the producer and witnessed and tested by the testing laboratory, in accordance with ACI 301 Section 4. Proportioning on the basis of field experience with complete statistical data, not more than one year old from date of submittal and spanning no less than 60 calendar days, to confirm mixes is acceptable.
- C. Provide concrete which will develop ultimate compressive strength at 28 days equal to that noted on drawings and listed below.

D. Concrete Grades:

Mix No.	Strength	Air Yes/No	Max. Aggregate Size	W/C or W/(C&P)*
1	3500	Y	1"	0.60
2	3500	N	1"	0.60
3	3500	Y	3/8"	0.60
4	4000	Y	1"	0.54
5	4000	N	1"	0.54
6	4000	Y	3/8"	0.52

* Water-Cementitious Ratio: Concrete mixes are required to comply with both the minimum strength and maximum water-cementitious ratios indicated above. Maximum W/C or W/(C&P) is required as an indication of overall concrete quality and may well produce strengths higher than the minimum required.

E. Concrete Use:

Element	Mix No.	Exposure Class*
1. Footings	2	F0
2. Wall Footings	2	P0
3. Slab on Grade	1, 2	S0
4. Columns and Poured Walls	4	F0
5. Elevated Slabs and Beams	5	F0
6. Pumped Elements, Tie Beams, Tie Columns	6	F0
7. Slabs on Steel Deck	5	F0

* Letter in Exposure Category denotes Exposure Class:

F: Freezing and thawing.

S: Sulfate.

P: Requires low permeability.

C: Corrosion protection of reinforcement.

F. Design Slump:

1. General: 4 inches.
2. Concrete Containing High Range Water Reducer: 2 to 3 inches before addition of HRWR, 8 inches after.
3. Slump Tolerance: Plus/minus 1 inch.

G. Chloride Ion Content for Corrosion Protection: Determine the chloride content of the component concrete materials, excluding admixtures, and provide this information to the Architect when submitting mix design. Design mixes will not be approved when the sum of chloride content of component materials indicates that the concrete mix derived from those materials will have a water soluble chloride ion content exceeding 0.1% for concrete exposed to the elements and 0.2% for concrete protected from the elements, when percent is determined by weight of cement. When the source of any component material for the concrete is changed or when the design mix is altered, a chloride content determination test shall be made immediately. Resubmit the altered design mix for approval by the Architect.

H. Cementitious Materials: Minimum Portland cement content of any concrete mix containing slag cement is 280 lbs., for all other concrete mixes, minimum portland cement content is 423 lbs. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Provide concrete mixes having a fly ash content of 15% to 20%, by weight, of cementitious material.
- I. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an entrained air content of 3 to 5 percent, except, 1 to 3 percent entrapped air for concrete to receive a hard trowel finish, (floor slabs), unless otherwise indicated.
 - O. Admixtures: Use admixtures according to manufacturer's written instructions.
 1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in all structural concrete.
 2. Use water-reducing and retarding admixture when ambient temperature is 85 degrees F or higher and/or low humidity, or other adverse placement conditions exist.
 3. Use high range water-reducing admixture in pumped concrete, walls 8" thick and less, at areas of reinforcing steel congestion, and as required for placement and workability, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.40.
 - P. Adjustment to Concrete Mixes: Mix design adjustments may be requested by contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to Owner and as accepted by Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in work.

2.12 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94, and furnish batch ticket information.
- B. Mixing and Delivery Time: When air temperature is between 95 and 100 degrees F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 100 degrees F, reduce mixing and delivery time to 60 minutes.
 1. Concrete Containing Corrosion Inhibitor: Reduce mixing and delivery time to one hour.
- C. Provide batch ticket for each ready-mixed batch discharged and used in the Work, indicating Project identification name and number, date, mix type and number, batch time, mix time, quantity, and amount of water added and amount of water withheld at the plant. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 VERIFICATION OF CONDITIONS:

- A. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
- B. 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. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor bolts, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges".
 - 2. Install dovetail anchor slots in concrete structures as indicated.
 - 3. Do not provide sleeves or openings in structural members unless shown on the structural drawings or approved by the Architect.

3.4 INSTALLATION OF VAPOR RETARDER

- A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders in accordance with ASTM E1643 and manufacturer's written instructions. Use below interior floor slabs and as indicated on the Contract Documents.
 - 1. Lap joints 6 inches and seal with manufacturer's recommended tape.
 - 2. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
 - 3. Protect vapor retarder during placement of reinforcement and concrete.
 - a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

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. Provide dowels as shown on drawings or as required by Architect. Do not continue reinforcement through sides of strip placements of slabs.

2. For members 5" thick or more, form keys from preformed galvanized steel, plastic keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete. Submit detail to Architect for review.
 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs. Allow 4 hours (minimum) between when column or wall is cast and when concrete supported by column or wall is cast.
 5. Space vertical joints in walls at 40 feet o.c. U.O.N. on drawings. Place control joints at 20 feet o.c. between construction joints U.O.N. on drawings. If locations are not shown, locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces. In beams and girders use epoxy-bonding adhesive at locations when fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated on drawings. If requested, the contractor shall prepare and submit to the Architect a joint layout. Construct contraction joints as follows:
1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades using the "Soff-Cut" early entry dry-cut saws. Cut 1/8 inch wide and 1/4 to 1/3 of slab depth deep joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks. This is usually within 2 hours of final finish at each control joint but not more than 8 hours after completion of concrete pour.
 2. 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.
- 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. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Coordinate construction and control joints with requirements of finish material joints.

3.6 WATERSTOPS

- A. Self-Expanding Strip Waterstops: Install in construction joints at locations indicated, according to manufacturer's written instructions, adhesive bonding or mechanically fastening and firmly pressing into place. Install in longest lengths practicable.

3.7 CONCRETE PLACEMENT

- A. Complete the following before placing concrete:

1. Excavate and compact subgrade, arrange for compaction testing, spray termite treatment on grade, place vapor barrier and remove excess water.
 2. Secure all formwork. Verify that shoring and reshoring has been inspected and accepted by Delegated Engineer. Moisten wood forms except where form coatings are used.
 3. Accurately locate all steel reinforcement, conduits, outlet boxes, anchors, hangers, sleeves, bolts, expansion joint materials and other embedded items and secure against shifting during concrete placement or consolidation.
 4. Accurately locate bearing pads on true, level, and uniform surfaces and secure against shifting during concrete placement.
 5. Cooperate with other trades and verify that their work is installed.
 6. Repair any damage to vapor retarder.
 7. Notify testing agency to test concrete.
 8. Ensure that all required inspections are performed.
- B. Comply with ACI 301, ACI 304, ACI 308 and ACI 318.
- C. Jobsite Tempering: Place concrete within 1-1/2 hours after introduction of water to mix. Submit time stamped batching tickets upon delivery of concrete to job site.
1. Do not add water to ready-mix concrete except as provided in ASTM C94, Paragraph 12.7. When so allowed, limit addition of water to amount withheld at plant as indicated on batch ticket. Water shall be added prior to initial discharge of concrete. No water may be added once concrete placement has started. Addition of water may only be authorized by Architect, the concrete producer's quality control representative, a preapproved representative of Contractor, or the Special Inspector.
 2. Concrete produced with high range water reducer may only be tempered with additional high range water reducer.
- D. 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 specified. Deposit concrete to avoid segregation.
1. Maximum height of concrete free fall is 4 feet. Columns up to **8 [10]** feet in height may be poured in one lift. Concrete in columns and walls over **8 [10]** feet may be poured full height with the use of drop chutes or tremies or up to a maximum of 16 feet if HRWR admix concrete is used.
- E. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators 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 mix constituents to segregate.
 3. Concrete in columns and walls shall be cast at least twenty-four hours before horizontal members they support are cast. Exception: Concrete in tie columns and grout in masonry cells shall be cast at least four hours before beams or slabs are cast on top of masonry.

- F. 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. 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.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using highway bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- G. Pumping: Slumps in excess of six (6) inches at the pump will not be permitted except for concrete produced with HRWR. If placing by means of pump, a specifically designed concrete mix shall be submitted to the Architect for review. No pump lines smaller than 4 inches will be permitted. Exception: A 3" pump line may be used for 8" wide beams and columns cast on top of or between masonry walls or for filling masonry cells.
- H. 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. Cold weather is defined as a period when, for more than three (3) consecutive days, the average daily air temperature is less than 40 degrees F and the air temperature is not greater than 50 degrees F for more than 1/2 of any 24-hour period. The average daily air temperature is the average of the highest and lowest temperatures occurring during the period from Midnight to Midnight.
1. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F at point of placement.
 2. Provide protected and heated environments for onsite storage of test cylinders.
 3. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 4. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators.
 5. Temporary heat devices shall be operated with special care to protect against concentrations of heat, or direct contact with combustion gases. All surfaces within the enclosure shall be kept wet for curing.
- I. Hot-Weather Placement: Place concrete according to recommendations in ACI 305.1 and as follows, except concrete temperature shall not exceed 100 degrees F:
1. Cool ingredients before mixing to maintain concrete temperature below 100 degrees F at time of placement.
 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.
 4. Use Type D water reducing admixtures when ambient temperature exceeds 85 degrees F or other adverse placing conditions exist.
- J. Do not place concrete in exposed conditions when it is raining unless adequate protection is provided.

3.8 FINISHING FORMED SURFACES

- A. Rough-Formed Finish ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding 1/4" rubbed down or chipped off. Use for concrete surfaces not exposed to view in the finished work.
- B. Smooth-Formed Finish ACI 301 Surface Finish SF-3.0: 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 defective areas. Remove fins and other projections exceeding 1/8 inch in height.
 - 1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or staining.
 - 2. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, to be covered with a coating or covering material applied directly to concrete.
- C. Rubbed Finish: Apply the following to smooth-formed finished concrete:
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 - 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 - 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
- D. Wall Surfaces Exposed to Public: Provide elastomeric form liner or steel forms for cast-in-place concrete wall surfaces exposed to the general public.
- E. 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.

3.9 FINISHING FLOORS AND SLABS

- A. General: Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces. Slope surfaces to drains.
- 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 indicated and to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes.
- C. Float Finish: Begin floating when bleed water has disappeared and when concrete has stiffened sufficiently to permit operation of power driven floats. 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 restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first trowel finish 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 and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. When concrete is still plastic, slightly scarify surface with a fine broom.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and 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.
- G. Floor Flatness and Levelness: Finish surfaces to the following tolerances according to ASTM E1155 for a randomly trafficked floor surface and measured within 72 hours and before supporting formwork or shoring is removed:
1. Scratch finish or Non-Critical Floors, such as Mechanical Rooms, Non-Public Unfinished Areas, Parking Slabs: Specified overall values of flatness, F_F 20; and levelness, F_L 15; with minimum local values of flatness, F_F 15; and levelness, F_L 10.
 2. Float Finish: Specified overall values of flatness, F_F 25; and levelness, F_L 20; with minimum local values of flatness, F_F 17; and levelness, F_L 15.
 3. Carpeted Slabs: Specified overall values of flatness, F_F 25; and levelness, F_L 20; with minimum local values of flatness, F_F 17; and levelness, F_L 15.
 4. Thin or No Floor Covering: Specified overall values of flatness F_F 35; and levelness, $F(L)$ 25; with minimum local values of flatness, F_F 24; and levelness, F_L 17; for suspended slabs.
 5. Specified overall values of flatness, F_F 45; and levelness, F_L 35; with minimum local values of flatness, F_F 30; and levelness, F_L 24.
 6. Specified Overall Value (SOV): F_F 50; and, F_L 25 with minimum local value (MLV): F_F 40 and F_L 17.

- H. Floor Flatness and Levelness Acceptance: The Architect may authorize the testing agency to verify that the specified F_F and F_L numbers have been achieved for any slab pours except for unshored or sloped construction. F_F and F_L Minimum Local Area is defined as any bay delineated by columns. Slabs that do not meet the specified F_F or F_L numbers shall be removed and replaced. Alternatively, the Contractor may propose repairs to the slab or a credit to the Project.

3.10 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete 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 of manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.
- E. Base Plates and Foundations: Use specified non-shrink, non-metallic grout. Where applicable, grout at least 3 days prior to casting concrete on supported structure.

3.11 CONCRETE PROTECTION AND CURING

- A. General: Comply with ACI 308 "Recommended Practice for Curing Concrete" and ACI 301. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305.1 for hot-weather protection during curing.
- B. 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.
- C. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including slabs, concrete floor toppings, and other surfaces.
- D. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Curing Compound: Apply to all concrete surfaces that are not permanently exposed. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Provide a second coat applied at 90 degrees to initial application within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - 2. Curing and Sealing Compound: Apply to permanently exposed concrete surfaces. Apply uniformly 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. 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.
 4. 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.
 - 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

3.12 TOLERANCES

- A. Conform to ACI 117.

3.13 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. 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 but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. If reinforcing steel is exposed, remove concrete to provide a minimum of 3/4" clearance all around. Prior to patching allow the Architect and Threshold Inspector adequate time to review prepared areas. Clean, dampen with water, and brush-coat prepared surfaces with bonding agent or slurry coat. Fill and compact with dry pack grout or non-shrink non-metallic grout before bonding agent has dried. Fill form-tie voids with cement grout, dry pack grout 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.
- C. Repairing Unformed Surfaces: Test unformed surfaces, such as 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.
1. Repair finished surfaces containing defects. 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 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 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 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix 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 dry pack grout or non-shrink non-metallic grout. 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.
- D. Perform structural repairs of concrete, not covered herein, only with Architect's and Structural Engineer's approval, using repair procedures they recommend.
- E. Other repair materials and installation not specified above may be used, subject to Architect's approval.

3.14 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include those specified in this Article.
- B. Testing Services: Sample concrete after all water and admixtures have been added. Testing of composite samples of fresh concrete obtained according to ASTM C172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day. For slabs 6" or thinner, increase frequency to each 50 cu. yd. or fraction thereof of each concrete mix placed each day.
 2. Slump: ASTM C143; one test at point of placement for each composite sample. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C231, pressure method, for normal-weight concrete; ASTM C173, volumetric method, for structural lightweight concrete; one test for each composite sample.
 4. Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40 degrees F and below and when 85 degrees F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C31
 - a. Cast and laboratory cure one set of four standard cylinder specimens for each composite sample. For pumped concrete, take sample at point of placement.
 6. Compressive-Strength Tests of Laboratory Cured Specimens: ASTM C39; test one specimen at 7 days for information and three at 28 days for acceptance. If one of the first two 28-day tests falls below specified strength, test the remaining specimen at 56 days.
- C. Strength of each concrete mix will be satisfactory if every average of any three consecutive compressive-strength tests (3 sets of 2 cylinders each) equals or exceeds specified compressive strength and no compressive-strength test (1 set of 2 cylinders) value falls below specified compressive strength by 10% or 500 psi, whichever is less.
- D. Strength tests that are not satisfactory indicate questionable concrete. The testing agency and Contractor shall submit to the Architect a report of the questionable concrete plus the two test reports immediately prior to and after (5 reports total) for evaluation.
1. If the questionable concrete is not accepted by the Architect, the testing agency shall take core tests per ACI 301 and ASTM C42 minimum diameter of cores is 4 inches. Concrete will be considered structurally adequate if average of 3 cores is at least 85% f'c and no single core is less than 75% f'c.
 2. Concrete not considered adequate by core testing shall be removed and replaced or load tested per ACI 318, Chapter 20.
- E. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for each test.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42 or by other methods as directed by Architect.
- G. The contractor may be required to pay all costs of additional testing or evaluation of questionable concrete and provide a credit to the Owner for acceptance of questionable concrete.
- H. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.

3.15 PROTECTION

- A. Protect concrete surfaces as follows:
 - 1. Protect from petroleum stains.
 - 2. Diaper hydraulic equipment used over concrete surfaces.
 - 3. Prohibit vehicles from interior concrete slabs.
 - 4. Prohibit use of pipe-cutting machinery over concrete surfaces.
 - 5. Prohibit placement of steel items on concrete surfaces.
 - 6. Prohibit use of acids or acidic detergents over concrete surfaces.
 - 7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

- B. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 033300

**SECTION 033543
POLISHED CONCRETE FINISHING**

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Grinding and honing of the slab surface to receive clear reactive, penetrating liquid hardener/densifier to interior concrete.
 - 2. Application of clear reactive, penetrating liquid hardener.
 - 3. Progressively polishing and burnishing of the slab surface to achieve Finish Requirements.
 - 4. Application of stain resistant surface treatment.
- B. Related Requirements:
 - 1. Section 03 30 00- Cast-in-Place Concrete.

1.02 REFERENCES

- A. American National Standard Institute / National Floor Safety Institute
 - 1. ANSI/NSFI B101.1 Test Method for Measuring Wet SCOF of Common Hard-Surface Floor Materials.
- B. ASTM International (ASTM):
 - 1. C1028 - Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
 - 2. C1353 - Standard Test Method for Abrasion Resistance of Dimension Stone Subjected to Foot Traffic Using a Rotary Platform, Double-Head Abraser
 - 3. D523- Standard Test Method for Specular Gloss.
 - 4. D1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
 - 5. D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
 - 6. E96/96M Method B (Water Method) - Standard Test Methods for Water Vapor Transmission of Materials.
 - 7. G154 -Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Installation Meeting: Convene before the start of work on new concrete slabs, patching of existing concrete slabs and start of application of concrete finish system.
 - 1. Require attendance of parties directly affecting work of this Section, including the Owner's Representative, Contractor, Architect, concrete installer, and applicator. Meeting should only convene when required parties are present.
 - 2. Review the following:
 - a. Physical requirements of completed concrete slab and slab finish.
 - b. Locations and time of test areas.
 - c. Protection of surfaces not scheduled for finish application.
 - d. Surface preparation.
 - e. Application procedure.
 - f. Quality control.
 - g. Cleaning.
 - h. Protection of finish system.
 - i. Coordination with other work.

1.04 SUBMITTALS

- A. Product Data:

1. Submit manufacturer's product data sheets and tested physical and performance properties on products to be used for the work.
- B. VOC Certification: Submit certification that products furnished comply with regulations controlling use of volatile organic compounds (VOC).
- C. Certificates:
 1. Certificates by manufacturer stating that installer is listed applicator of special concrete finishes, and has completed the necessary training programs.
- D. Floor Protection Plan.
- E. Mock-up:
 1. Install 4' x 4' mock-up panels of each color demonstrating specified concrete color and finish. Mock-up panels shall be independent and may not be integrated into the final project. Keep approved panels available for comparison throughout the project.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Applicator to be familiar with the specified requirements and the methods needed for proper performance of work of this section. Applicator must have availability of proper equipment to perform work within scope of this project on a timely basis. Applicator should have successfully performed a minimum of 5 projects of similar scope and complexity.
 2. Mock-up: On site, prior to the start of the polished concrete finishing process.
 - a. Require attendance of parties directly affecting work of this Section, including the Contractor, Architect, applicator, and Owner's Representative.
 - b. Notify the above parties one week in advance of date and time when mock-up will be completed.
 - c. Demonstrate the materials, equipment and application methods to be used for work specified herein in pre-approved location approximately 50 sq. ft. in area or as directed by [Architect][Owner's Representative].
 - d. Retain approved mock-up during construction as a standard for judging the completed work. Areas may remain as part of the completed work.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original containers, with seals unbroken, bearing manufacturer labels indicating brand name and directions for storage.
- B. Store concrete hardener/densifier and surface protectant treatment in environment recommended on published manufacturer's product data sheets.
 1. Store containers upright in a cool, dry, well-ventilated place, out of the sun with temperature between 40 and 100 degrees F (4 and 38 degrees C).
 2. Protect from freezing.
 3. Store away from other chemicals and potential sources of contamination.
 4. Keep lights, fire, sparks and heat away from containers.
 5. Do not drop containers or slide across sharp objects.
 6. Do not stack pallets more than three high.
 7. Keep containers tightly closed when not in use.

1.07 FIELD CONDITIONS

- A. Environmental limitations:
 1. Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting performance and finishing requirements.
- B. Close areas to traffic during floor application and after application for time period recommended in writing by manufacturer.
- C. Protect the completed slab to prevent damage by the other trades during floor completion.
- D. Temperature Limitations:

1. Apply when surface and air temperature are between 40 degrees F (4 degrees C) and 95 degrees F (35 degrees C) unless otherwise indicated by manufacturer's written instructions.
 2. Apply when surface and air temperatures are expected to remain above 40 degrees F (4 degrees C) for a minimum of 8 hours after application, unless otherwise indicated by manufacturer's written instructions.
- E. Apply when air conditions are calm to minimize surface treatment contacting surface not intended to be finished.
- F. Do not apply to frozen substrate. Allow adequate time for substrate to thaw if freezing conditions exist before application.
- G. Apply a minimum of 24 hours after rain event. Suspend application when rain is anticipated for a period of 8 hours after application, unless otherwise indicated by manufacturer's written instructions.
- H. Temporary Heat: Ambient temperature of 50 degrees F (10 degrees C) minimum.
- I. Ventilation: Provide adequate ventilation in confined or enclosed areas in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Substitutions: Products listed in this section are to be considered the basis of design. Equal products from other manufacturers can be submitted to the architect for evaluation prior to the bid date.

2.02 MATERIALS

- A. Color Additives:
1. Non-stained concrete: natural concrete, no color additives.
- B. Penetrating Concrete Hardener/Densifier: Lithium silicate hardener/densifier.
1. Basis of Design: Consolideck LS, manufactured by PROSOCO, Inc., Lawrence, KS, (800) 255-4255, www.prosoco.com.
 2. Subject to compliance with the following requirements:
 - a. Comply with national, state and district AIM VOC regulations and contain 50 g/L or less.
 - b. Registered as an approved NSF International/Nonfood Compound Registration.
 - c. Abrasion Resistance: Greater than 50 percent improvement over untreated samples when tested in accordance with ASTM C1353.
 - d. Achieve 'High Traction Range' readings when tested in accordance with ANSI B101.1.
 - e. Coefficient of Friction: Greater than 0.60 dry, Greater than 0.60 wet when tested in accordance with ASTM C1028.
 - f. Adhesion: Greater than 10 percent increase in pull-off strength when compared to an untreated sample when tested in accordance with ASTM D4541.
 - g. Water Vapor Transmission: 100 percent retained when compared to untreated samples when tested in accordance with ASTM E96/96M Method B (Water Method).
 - h. UV Stability: No degradation or yellowing of material when tested in accordance with ASTM G154.
- C. Interior Concrete Protective Treatments:
1. General Purpose high-gloss film forming premium sealer, lithium silicate hardener/densifier.
 - a. Product: Consolideck LSGuard, manufactured by PROSOCO, Inc., Lawrence, KS, (800) 255-4255, www.prosoco.com.
 - b. Subject to compliance with the following requirements:
 - 1) Comply with national, state and district AIM VOC regulations.

- 2) Registered as an approved NSF International/Nonfood Compound Registration.
- 3) Achieve 'High Traction Range' readings when tested in accordance with ANSI B101.1.
- 4) Coefficient of Friction: Greater than 0.60 dry, greater than 0.60 wet when tested in accordance with ASTM C1028.
- 5) Adhesion: : Greater than 10 percent increase in pull-off strength when compared to an untreated sample when tested in accordance with ASTM D4541.
- 6) UV Stability: No degradation or yellowing of material when tested in accordance with ASTM G154.

2.03 EQUIPMENT

- A. Auto Scrubber Machine: For cleaning operations.
- B. Hand Grinder or stand-up edger for edge grinding/polishing.
- C. Grinding/Polishing Equipment:
 1. Dry grinding/polishing machines shall include a dust extraction system, including HEPA filtration vacuum.
- D. Diamond Segments:
 1. Use heads from the same manufacturers throughout the entirety of the project.
- E. Diamond Heads Types:
 1. Metal Diamonds: 80 or 150.
 2. Hybrid Style Diamonds: 50 or 100.
 3. Resin Bonded, Phenolic Diamonds: 100, 200, 400, 800, 1500, and 3000 (if necessary).
- F. Burnishing Machine and Burnishing Pads to produce specified results.
 1. Burnishing Machine: High speed burnisher, generating pad speeds of 1,500 RPM or higher, as recommended by protective treatment manufacturer. Dust skirt must be installed at time of work.
 2. Burnishing Pads: as recommended by protective treatment manufacturer.
 - a. White Burnishing Pad, non-abrasive.
 - b. Consolideck Heat Pad manufactured by PROSOCO, Inc., Lawrence, KS, (800) 255-4255, www.prosoco.com.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrate with installer present for conditions affecting performance of finish. Correct conditions detrimental to timely and proper work. Notify the Architect in writing of conditions detrimental to the proper and timely completion of the work.
- B. Do not begin installation until all unsatisfactory conditions are resolved. Beginning work constitutes acceptance of site conditions and responsibility for defective installation caused by prior observable conditions.

3.02 PREPARATION

- A. Cure time: concrete slabs scheduled for polished concrete finish shall be watered to maintain maximum moisture content for 7 days after initial concrete pour.
- B. Take all necessary precautions to protect adjacent spaces on the same floor and below from any negative effects that may result from concrete grinding, honing, or finishing process.
- C. Clean dirt, dust, oil, grease and other contaminants that interfere with penetration or performance of specified product from surfaces. Use appropriate concrete cleaners approved by the concrete surface treatment manufacturer where necessary. Rinse thoroughly using pressure water spray to remove cleaner residues. Allow surfaces to dry completely before application of product.

- D. Repair, patch and fill cracks, voids, defects and damaged areas in surface as approved by the Architect. Allow repair materials to cure completely before application of product.
- E. All holes in concrete floor in areas to receive polished concrete floor finish to be patched be filled by polished concrete subcontractor to provide for correct patch material to result in uniform color and finish.
- F. Variations in substrate texture and color will affect final appearance and should be corrected prior to application of sealer/hardener system and the polishing steps.
- G. Protect surrounding areas prior to application. If product is accidentally misapplied to adjacent surfaces, flush with water immediately before material dries.
- H. Avoid contact in areas not to be treated. Avoid contact with metal, glass and painted surfaces.
- I. Seal open joints in accordance with Section 07 90 00.
- J. Apply specified sealants and caulking and allow complete curing before application of penetrating concrete hardener/densifier.
- K. Do not proceed until unsatisfactory conditions have been corrected.

3.03 CONCRETE GRINDING, HONING, AND POLISHING

- A. Adhere to industry standard grinding, honing, and polishing procedures for dry and wet grinding and honing.
- B. Scrub and rinse slab surface with clean water and vacuum with auto-scrubber between and after final passes.
- C. Sequential progression of diamond tooling steps shall be required and limited to no more than double the grit value of the previous diamonds used.
- D. Overlap adjacent passes by 25 percent.
- E. Perform each pass perpendicular to the other pass north/south then east/west; multiple passes may be needed.
- F. Progressively grind, hone and polish the slab surface utilizing approved diamond segments as necessary to produce Finishing requirements.
 - 1. Apply liquid concrete repair material to fill gaps, voids and pop-outs during grinding operation per manufacturer's published recommendations.

3.04 APPLICATION OF PENETRATING CONCRETE HARDENER/DENSIFIER

- A. Apply hardener/densifier at the rate of 500 to 700 square feet per gallon with a low pressure sprayer fitted with a 0.5 gpm spray tip. (Typically after 200-grit and no later than 400 grit).
- B. Apply sufficient material to keep concrete surface wet for 5 to 10 minute period, without producing puddles.
- C. Allow treated surface to dry.
- D. Continue progressively polishing floor with required resin diamonds as necessary to produce desired final finish.

3.05 APPLICATION OF INTERIOR CONCRETE PROTECTIVE TREATMENT

- A. Application of general purpose, high gloss protective treatment:
 - 1. Apply per manufacturer's published recommendations to clean, dry slab at the completion of mechanically polishing the slab surface.
 - 2. Lightly wet a clean microfiber pad with protective treatment and wring out excess, leaving the pad damp.
 - 3. Working from one control joint to another, apply a light, fine spray of protective treatment to a small section of the floor using a clean, pump-up sprayer fitted with a 0.5 gpm spray tip, at an estimated coverage rate of 2000 to 3000 square feet per gallon.
 - 4. Using the damp microfiber pad and firm downward pressure, immediately spread the protective treatment to produce a thin, even coating. Spread the product as far as possible

while maintaining a wet edge. Properly applied, protective treatment dries quickly. Stop spreading once drying begins. Avoid overlapping.

5. Allow to dry tack free, typically 20 to 60 minutes.
6. Once dry, high- speed burnish slab surface fitted with manufacturer recommended burnishing pad to increase gloss and to help the treatment fuse and bond with the concrete for increased durability and longevity. Surface temperatures immediately behind the burnisher must achieve 90.5 degrees Fahrenheit. (Burnish between coats if multiple applications are desired.)
7. Repeat above steps 1 through 6, as necessary for additional applications of protective treatment, to achieve desired final finish (Maximum 3 coats).
8. Retain paragraph below if a general purpose, medium gloss protective treatment is required.

3.06 SLAB PROTECTION

- A. Protect finished floors to prevent damage including staining, gouges and scratching by construction traffic and activities until possession.
- B. Do not drag or drop equipment or material across the slab which will scratch or chip it.
- C. Inspect tires for debris prior to use on slab. Remove embedded items which may cause damage to floor slab.
- D. Clean up spills on slab immediately. Provide cleaning chemicals and absorptive materials.
- E. Develop a concrete protection procedure which addresses the following procedures:
 1. Communication of protection plan to subcontractors and vendors.
 2. Procedures for cleaning up slab spills, including use of and availability of cleaning chemicals and absorptive materials at Site.
- F. Provide a clean slab surface using concrete maintenance cleaner within an auto scrubber, equipped with soft nylon brushes, in accordance with manufacturer's published recommendations.

3.07 FINISHING REQUIREMENTS

- A. Appearance:
 1. Interior exposed finished slab areas must consist of the following:
 - a. Slab surface must meet the desired sheen, as discussed in Pre-Installation meeting and be consistent with approved Mock-up.
 - b. Slab surface must have a consistent look and exhibit a finish that has no evidence of streaking or burnish marks.
 - c. White residue or hazy appearance is not acceptable.
 - d. Exposure of aggregate beyond CPAA B-Fine Aggregate is not acceptable.
 - e. Interior exposed finished slab areas must consist of the following CPAA Gloss Level:
 - 1) Finished Gloss Level 3 - Semi-Polished Gloss Appearance.

END OF SECTION 033543

SECTION 042900
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. This Section includes grouted, reinforced masonry consisting of grout and reinforcing steel.
- B. Related Sections:
 - 1. Section 032000 "Concrete Reinforcement" for reinforcing steel.
 - 2. Section 033000 "Cast-In-Place Concrete" for concrete.
 - 3. Section 042000 "Unit Masonry" for all other elements of masonry construction.

1.3 DEFINITIONS

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

1.4 PERFORMANCE AND PRECONSTRUCTION TESTING REQUIREMENTS

- A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28-days. Contractor shall determine the net-area compressive strength of masonry based on 1.4B or 1.4C. Mortar for unit masonry shall comply with ASTM C270. Contractor shall meet ASTM C270 requirements based on the Property or Performance Specification.
- B. 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 ACI 530.1/ASCE 6/TMS 602.
 - 1. Preconstruction Testing Service: Owner 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.
 - a. Concrete Masonry Unit Test (Property and Proportion Specification): For each type of unit required, according to ASTM C140 for compressive strength.
 - b. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.
 - c. Mortar Test (Property Specification): For each mix required, according to ASTM C109 for compressive strength.

- d. Mortar Test (Property Specification): For each mix required, according to ASTM C780 for compressive strength.
- e. Grout Test (Compressive Strength) (Property and Performance Specification): For each mix required, according to ASTM C1019.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel: Show fabrication and installation details Reinforcing Steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show bar sizes, schedules, bent bar diagrams and other arrangements as required for fabrication and placement. Show elevations of reinforced walls.
- C. Material Test Reports: From a qualified testing agency indicating and interpreting test results of the following for compliance with requirements indicated:
 - 1. Grout mixes complying with material and compressive strength requirements of ASTM C476 for fine grout. Include description of type and proportions of grout ingredients and design slump.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency
- B. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements
 - b. 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.
 - 4. Grout mixes. Include description of type and proportions of ingredients
 - 5. Reinforcing bars.
 - 6. Joint reinforcement.
 - 7. Anchors, ties, and metal accessories.
- C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 - 1. Test according to ASTM C109 for compressive strength, ASTM C1506 for water retention, and ASTM C91 for air content.

2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirements.
- D. 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 ACI 530.1/ASCE 6/TMS 602.
- E. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C1093 for testing indicated.
- B. Masonry Standard: Comply with the Florida Building Code, 7th Edition and ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1.8 DELIVERY, STORAGE, AND HANDLING

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

1.9 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Refer to Section 042000 "Unit Masonry" for masonry materials and accessories and grout materials not included in this section.

2.2 MANUFACTURERS

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

2.3 CONCRETE MASONRY UNITS

- A. CMUs: ASTM C90.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2,000 psi.
 - 2. Density Classification: Normal weight.
- B. Shapes: Provide shapes indicated and as follows, with exposed surfaces, matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for corners, jambs, sashes, control joints, lintels, bond beams and other special conditions.

2.4 CONCRETE AND MASONRY LINTELS

A. General: Provide one of the following:

1. Provide precast lintels made from concrete matching concrete masonry units in color, texture, and compressive strength and with reinforcing bars indicated or required to support loads indicated. Cure precast lintels by the same method used for concrete masonry units.
2. Provide prefabricated or built-in-place masonry lintels. Use specially formed bond beam units with reinforcing bars placed as indicated and filled with fine grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.5 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150, 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 C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Mortar Cement: ASTM C1329.
- E. Aggregate for Mortar: ASTM C144
- F. Aggregate for Grout: ASTM C404 for fine grout.
- G. Water: Potable.

2.6 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615, Grade 60. Shop fabricate bent bars.
- B. Masonry Joint Reinforcement, General: ASTM A 951.
1. Interior Walls: Mill- galvanized, carbon steel.
 2. Exterior Walls: Hot-dip galvanized, carbon, ASTM A 153 with a coating thickness of 1.50 oz/sf steel.
 3. Wire Size for Side Rods: 0.148-inch diameter.
 4. Wire Size for Cross Rods: 0.148-inch diameter.
 5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

- C. Masonry Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods complying with ASTM A951.
- D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication.
 - 1. Provide units with either two loops or four loops as needed for number of bars indicated.

2.7 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site
- C. Mortar for Unit Masonry: Comply with ASTM C270 Proportion or Property Specification. Provide the following types of mortar for applications stated unless another type is indicated.
 - 1. For masonry retaining earth, use Type M.
 - 2. For all other masonry, use Type S.
- D. Grout for Unit Masonry: Comply with ASTM C476 with a minimum compressive strength of 3000 psi in 28 days.
 - 1. Use fine grout with a slump of 8 to 10 inches as measured according to ASTM C143.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that foundations are within tolerances specified.
 - 2. Verify that reinforcing dowels are properly placed.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Refer to Section 042000 "Unit Masonry" for general installation requirements of unit masonry.
- B. Build chases and recesses to accommodate items specified in this and other Sections.

- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to the opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units which are not in multiples of 8 inches. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Allow wet masonry units to dry prior to placement.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

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

B. Lines and Levels:

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

C. Joints:

- 1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
- 2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
- 3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
- 4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, reinforcement, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern: Unless otherwise indicated, lay masonry in one-half running bond with vertical joint in each course centered on units in courses above and below, unless otherwise indicated on Drawings. Interlock each course at corners.
- C. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- D. Place clean units while the mortar is soft and plastic. Remove and relay in fresh mortar any unit disturbed to the extent that initial bond is broken after initial positioning.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- G. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
- H. Design, provide and install bracing that will assure stability of masonry during construction. Include provisions to project against wind or other natural or construction forces that might collapse or otherwise damage a partially or completely built masonry wall in a partially completed structure.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow masonry units 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 in grouted masonry, including starting course on footings.
 - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

3.6 MASONRY JOINT REINFORCEMENT

- A. General: Provide continuous masonry joint reinforcement as indicated. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch. Lap reinforcement a minimum of 6 inches.
 - 1. Space reinforcement not more than 16 inches o.c.

2. Space reinforcement not more than 8 inches o.c. in foundation walls.
 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections.
- D. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 3. Space anchors as indicated, but not more than 16 inches o.c. or as indicated on the drawings.

3.8 ANCHORING MASONRY TO CONCRETE

- A. Anchor masonry to concrete where masonry abuts or faces concrete to comply with the following:
1. Provide an open space not less than 3/8 inch wide between masonry and concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 3. Space anchors at 16 inches o.c. vertically and 36 inches.

3.9 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry as follows:
1. Install backer-rod in head joints and apply sealant after concrete masonry is complete.

3.10 LINTELS

- A. Provide concrete or masonry lintels where shown and where openings of more than 24 inches are shown. Reinforce and grout lintels as shown on the Drawings.

- B. Install steel lintels where indicated.
- C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.11 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores to support reinforced masonry elements during construction.
 - 1. Construct formwork to conform to shape, line, and dimensions shown. Make it 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 temporary loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements of ACI 530.1/ASCE 6/TMS 602 and as follows:
 - 1. Place reinforcement and accessories as indicated.
 - 2. Support and fasten reinforcement together to prevent displacement by construction loads or by placement of grout.
 - 3. Clean reinforcement by removing mud, oil, or other materials that will reduce the bond at the time grout is placed. Reinforcement with tightly bound rust and/or mill scale is acceptable without cleaning provided the dimensions and weights, including heights of deformations, of the cleaned sample are not reduced.
 - 4. Place all reinforcement prior to grouting. Tie vertical reinforcement to dowels at base of masonry with tie wire and thread masonry units over or around reinforcement. Support vertical reinforcement at 10 feet o.c. Extend vertical bars the specified lap length above top of pour and support bar in proper position at top of grout pour. Where vertical bars are placed after laying masonry, place wire loops extending into cells as masonry is laid and loosen before mortar sets. After insertion of bar, pull loops and bar to proper position and tie free ends.
 - 5. Do not bend reinforcement after it is embedded in grout.
 - 6. Splice bars only where indicated. Provide 48 bar diameter lap splices, unless otherwise noted. Place bars in contact and wire tie. Bars spliced by noncontact lap splices shall be spaced 6 inches apart (maximum).
 - 7. Bar placement tolerance is $\pm 1/2$ inches perpendicular to wall and 2 inches along wall. The clear distance between parallel bars that are not contact lap spliced shall be not less than 1 inch in walls and 1-1/2 inches in columns and pilasters. Maintain $1/4$ inch clear between bars and any face of masonry.
- C. Laying Masonry Walls: Construct masonry walls as follows:
 - 1. Lay masonry units to top of grout pour prior to placing grout. Maximum grout pour height is 12 feet or top of bond beam, whichever is lower.
 - 2. Construct wall such that vertical cells to be grouted are aligned and unobstructed openings for grout are 3 inches x 4 inches (minimum). Construct grout spaces free of mortar droppings, debris, loose aggregates, and any material deleterious to grout; or, clean the cells prior to grouting. Remove masonry protrusions extending 1/2 inch or more into cells to be grouted.
 - 3. Do not lay masonry until grouted masonry below is cured.

4. In bond beams, use special units or modify regular units to allow placement of horizontal bars. Place small mesh, expanded metal lath or wire screening in mortar joints under bond beam courses over cells of non-reinforced vertical cells.

- D. Cleanouts: Provide cleanout openings at each vertical bar at the base of walls in which one of the following applies:

1. Grout pour height exceeds 5 feet.
2. Vertical bars are not otherwise fastened to prevent displacement. In this case, use cleanout to securely tie bar in position.
3. To remove dust, dirt, mortar droppings, loose pieces of masonry and other foreign materials from cell and top of support in cells to be grouted.

Construct cleanout by cutting opening in face shell. Construct cleanouts with openings of sufficient size to permit removal of debris and tying of bars. Minimum size is 3 inches x 3 inches. After cleaning and inspection, close cleanout opening and brace closure to resist grout pressure.

- E. Grouting: Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.

1. Comply with requirements of ACI 530.1/ASCE 6/TMS 602.
2. Place grout within 1 1/2 hours from introducing water in the mixture and prior to initial set.
3. Confine grout to the areas indicated.
4. Place grout by pumping into grout spaces unless alternate methods are acceptable to the Architect.
5. Place grout continuously in lintels and bond beams. Grout walls in lifts not exceeding 5 feet or the elevation of top of bond beam, whichever is lower.
6. If grout pour during one day exceeds 5 feet, grout in lifts 5 feet each or less, with not less than 30 minutes and not more than 1 hour between lifts.
7. Terminate grout 1-1/2 inches below bond beam course or where cell above is to be grouted.
8. Place grout in bond beam course before filling vertical cores above bond beam.
9. Consolidate grout with mechanical vibrators having a 3/4 inch diameter head. Vibrate each lift and reconsolidate after 10 minutes. Grout pours 12 inches high or less may be puddled in lieu of mechanical vibration.

3.12 FIELD QUALITY CONTROL

- A. Testing: Contractor will engage a Testing Agency, acceptable to the Owner, to perform tests and prepare reports. Allow access to scaffolding and work areas, as needed to perform tests. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
1. Begin masonry construction only after the Testing Agency has verified proportions of site-prepared mortar.
- B. Testing Frequency: Four grout cubes will be sampled and tested for compressive strength per ASTM C1019 for each 5000 sq. ft. of wall surface.

3.13 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained or otherwise damaged or that do not match the adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Remove all mortar fins larger than 1/2 inch within cells to be reinforced.

END OF SECTION 042900

SECTION 051200
STRUCTURAL STEEL

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. The work specified in this section includes all labor, materials, equipment, permits, and services necessary for the furnishing, fabrication and erection of structural steel and related work, complete, in accordance with the Drawings and as specified herein, including the detailing of all connections.
- B. Structural steel is that work defined in AISC "Code of Standard Practice for Steel Buildings and Bridges" and as otherwise shown on Drawings.
- C. Related Requirements:
 - 1. Section 031000 "Concrete Formwork" for Placing Anchor Rods.
 - 2. Section 033000 "Cast-In-Place Concrete" for Grouting Base Plates.
 - 3. Section 053100 "Steel Deck."
 - 4. Section 055000 "Metal Fabrication."
 - 5. Section 078100 "Applied Fireproofing."
 - 6. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" and Section 099600 "High Performance Coatings."

1.3 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- B. Heavy Sections: Rolled and built-up sections as follows:
 - 1. Shapes included in ASTM A6 with flanges thicker than 1-1/2 inches.
 - 2. Welded built-up members with plates thicker than 2 inches.
 - 3. Column base plates thicker than 2 inches.

1.4 COORDINATION

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

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

1.5 RESPONSIBILITIES

- A. The Engineer of Record is responsible for the design of the steel framing and the connections that are fully detailed as presented in the Contract Documents.
- B. The fabricator is responsible for the preparation of Shop and Erection Drawings pursuant to the requirements of the Contract Documents. All connections that are not completely detailed on the drawings shall be designed by the Fabricator's Delegated Engineer. Submit signed and sealed connection details and calculations to the EOR for approval prior to submitting shop drawings. Once approved, the connection details may be incorporated in the shop drawings. The shop drawings are not required to be signed and sealed.
- C. The fabricator is responsible for the coordination of all surveyed field conditions and field measurements necessary for the detailing, fabrication and erection of their work. All field measurements shall be provided on the shop drawings prior to submittal.
- D. The Engineer of Record is responsible for the structural adequacy of the structure in the completed project. The erector is responsible for the means, methods and safety of the erection, including all temporary guys, beams, falsework, cribbing or other elements required for the erection operation. If the erector is unsure of these requirements, he shall retain a Florida Licensed Engineer to determine and design all temporary requirements.

1.6 PREINSTALLATION MEETINGS

- A. Preconstruction Meeting: There shall be a Preconstruction Meeting with the Owner, Architect, Structural Engineer, Contractor, Fabricator, Erector, and Testing Laboratory to clarify responsibilities and requirements as set forth in Division 01 "Project Management and Coordination".

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Submit to the Architect for acceptance, shop and erection drawings for all structural steel components. See "Shop Drawings and Other Submittals" notes regarding the possible reproduction of Structural Drawings for use as shop or erection drawings. Drawings shall include complete details, dimensions, schedules and procedures for the fabrication, assembly, and sequence of erection.
 - 2. No changes to the completed connection shown on the drawings will be considered without complying with the applicable requirements for substitutions. The fabricator shall submit details and complete calculations that clearly identify proposed substitutions for Engineer's review prior to preparation of detailed shop drawings. Proposed variations to details shown on the Contract Drawings will be considered and such variations must have preliminary acceptance prior to the preparation of detailed shop drawings. The details and calculations shall clearly show the capacity of the connections designed by the fabricator. The calculations shall show details of the assembled joint with all bolts and

- welds required. All design calculations, drawings and details for substitutions shall be signed, sealed and dated by the Delegated Engineer.
3. For structural steel connections indicated on the drawings to comply with design loads, include signed and sealed calculations by the qualified professional engineer responsible for their preparation under the following criteria:
 - a. Design all connections for the factored forces indicated on the drawings in accordance with all applicable codes and specifications.
 - b. Set connection work point at the intersection of member centerlines for all connection design and detailing.
 - c. The conceptual connections on the drawings show design intent and shall be completed for the member designated forces. Adapt those details to accommodate the atypical conditions. The conceptual connection does not show the complexity of the final connection designed for the required forces.
 - d. Design, detail, and install stiffeners, continuity plates, doubler plates as required to resist the indicated design forces. The member size is based on member behavior away from the connection.
 - e. All forces shown on the drawings act concurrently unless noted otherwise.
 - f. During bidding, if no moment is shown on the drawings, provide full moment capacity of the member of $.9 F_y Z$; and if no shear is shown, provide full shear capacity of $.6 F_y d_{tw}$. For missing tension forces, assume 95% of the tension member capacity.
 - g. Use the same bolt sizes shown on the drawings. All bolts with the same diameter shall be of the same grade. Skip one diameter size for bolts with different grades. Do not use oversized or slotted holes unless approved by EOR.
 - h. Shop drawings incorporating the design of the Delegated Engineer shall be reviewed and stamped by the Delegated Engineer prior to submittal to the EOR.
 4. Include details of cuts, connections, camber, holes, threaded fasteners and other pertinent data. Indicate welds by standard AWS A2.4 symbols and show size, length, and type of each weld. Show shop welds on shop drawings and field welds on erection drawings.
 5. Provide setting drawings, templates, and directions for installation of anchor rods, embeds and other anchorages to be installed by others.
 6. Indicate surface preparation, such as primed, galvanized, etc., of each surface of each piece.
- C. Acceptance of the Shop and Erection Drawings by the Architect/Engineer does not relieve the Fabricator of the responsibility for accuracy of detail dimensions on the shop drawings and the general fit-up of parts to be assembled in the field.
- D. Before welding is started, the steel fabricator and erector, as applicable, shall submit to the Architect a signed and sealed statement by a Florida Licensed Engineer, who specializes in the design of weldments, that he/she has provided written welding procedures for this Project, establishing the welding process, sequence of assembly, preheat, interpass and postheat requirements in general if high residual stresses are present, and in particular for all members requiring partial or complete penetration groove welding.

1.8 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Include lists of Qualification data for firms and persons specified in the "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.
- B. Welding certificates. Submit to Owner's inspection agency.

- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill Test Reports: Fabricator's certification that the chemical and physical properties of the following materials comply with the Project requirements:
 - 1. Structural steel
 - 2. Bolts, nuts and washers.
 - 3. Direct-tension indicators.
 - 4. Shear studs.
 - 5. Welding electrodes.
- E. Product Test Reports: For the following:
 - 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 2. Direct-tension indicators.
 - 3. Tension-control, high-strength, bolt-nut-washer assemblies.
 - 4. Shear stud connectors.
 - 5. Shop primers.
 - 6. Nonshrink grout.
- F. Product Data for each type of product specified, including the following:
 - 1. Bolts, nuts, and washers, including mechanical properties.
 - 2. Direct-tension indicators.
 - 3. Shear stud connectors.
 - 4. Structural steel coatings.
 - 5. Bearing pads
- G. Fabricator's Quality Control Program.
 - 1. Include welding and testing procedures.
- H. Fabricator's shop inspection and test reports.
- I. Substantiating data for primer on Class A faying surface.

1.9 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator with a minimum five years of documented successful experience on equivalent projects. Submit copy of résumé demonstrating equivalent project experience.
- B. Installer Qualifications: A qualified installer with a minimum five years of documented successful experience on equivalent projects. Submit copy of AISC Certification and résumé demonstrating equivalent project experience.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P2 or to SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators." Submit copy of SSPC Certification.
- D. Qualifications for welding work: Qualify welding procedures and operators in accordance with AWS "Standard Qualification Procedure".

1. The Fabricator for shop welds and the Erector for field welds shall retain a Florida Licensed Engineer, who specializes in the design of weldments to prepare a written welding program pursuant to the requirements of AWS D1.1. The program shall include all necessary Welding Procedure Specifications (WPS), all necessary requirements for qualification testing of WPS and welding personnel. The WPS shall include the welding process, sequence of assembly, preheat, interpass and postheat requirements. Welded joints of heavy sections and plates 2 inch thick and greater shall be detailed to limit the amount of weld metal. Double bevels shall be used in lieu of single bevels. Welding shall start at the most restrained part of the weldment and proceed to the least restrained.
2. The Fabricator and Erector, as applicable, shall conduct all necessary tests required by AWS D1.1 to qualify the WPS.
3. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests for the welding process and position used and have been continuously employed as a welder since certification. If recertification of welders is required, retesting will be Contractor's responsibility.

E. Stud Application Qualification Test:

1. Prior to erection, conduct stud application qualification tests in accordance with AWS D1.1 Chapter 7.6 and Annex IX. The tests are the responsibility of the Contractor or stud applicator.
2. Prepare specimen plates of A992 steel, minimum 1/2 inch thick, with an SP-6 surface preparation.
3. Weld a minimum of ten (10) studs through steel deck to the prepared plate(s). The studs and steel deck shall be of the same type as specified for use in the project. Test the studs by the bend test specified in AWS 7.6.6 or Annex IX.
4. If the tests are conducted by other than the Owner's testing agency, that agency shall be properly notified so that they may be present to witness the entire test procedure.

F. Codes and Standards: Comply with the following, unless more stringent provisions are indicated:

1. Florida Building Code, 7th Edition.
2. AISC 360, "Specification for Structural Steel Buildings."
3. AISC 303, "Code of Standard Practice for Steel Buildings and Bridges".
 - a. Paragraph 4.4. "Approval" is modified such that the Structural Engineer will return submittals to the Architect within ten working days from time of receipt.
4. RCSC's "Specification for Structural Joints using High Strength Bolts." Approved June 22, 2010.
5. AWS D1.1 "Structural Welding Code - Steel".
6. ASTM A6 "Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling."
7. S.S.P.C. Society for Protective Coatings.
8. Occupational Safety and Health Act (OSHA), as amended to date.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site at such intervals to insure uninterrupted progress of work
- B. Deliver anchor rods and anchorage devices which are to be embedded in cast-in-place concrete or masonry in ample time to not delay work.

- C. 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.
- D. Store fasteners in a protected place in sealed containers with manufacturer's labels intact until ready to use. Reseal open containers to prevent contamination by moisture or other deleterious substances. Store closed containers in a protective shelter to protect fasteners from dirt and moisture. Only as many fastener components as are anticipated to be installed during the work shift shall be taken from protective storage. Fastener components that are not incorporated into the work shall be returned to protective storage at the end of the work shift. Fasteners from open containers and fasteners that accumulate rust or dirt shall not be used and shall be immediately and permanently removed from the project site.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. Structural steel rolled W and WT shapes: ASTM A992, Grade 50.
- B. Structural steel rolled M, S, C and MC shapes and Angles: ASTM A36, Grade 36.
- C. Structural steel plates and bars: ASTM A36, Grade 36 and ASTM A572, Grade 50.
 - 1. All steel plates exceeding 2" in thickness shall conform to the requirements of ASTM A435, "Straight-Beam Ultrasonic Examination of Steel Plates", to assure delivery of steel plates free of gross internal discontinuities such as pipe, ruptures, or laminations. Plates shall be identified by stamping or stenciling "UT 435" adjacent to marking required by the material specification. The Fabricator shall submit to the Architect evidence of compliance by the mill with this requirement.
- D. Cold-formed hollow structural sections (HSS):
 - 1. Round sections: ASTM A500, Grade C, $F_y=46$ ksi.
 - 2. Square and Rectangular sections: ASTM A500, Grade C, $F_y=50$ ksi.
- E. Steel pipe: ASTM A53, Type E or S, Grade B, $F_y=35$ ksi.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. Unfinished threaded fasteners: ASTM A307, Grade A, regular low-carbon steel bolts and nuts.
 - 1. Provide square head and nuts.
- B. High-Strength Bolts, Nuts, and Washers: ASTM F3125, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959, Type 325-1, compressible-washer type with plain finish.
- C. High-Strength Bolts, Nuts, and Washers: ASTM F3125, Grade A490, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers with plain finish.
1. Direct-Tension Indicators: ASTM F 959, Type 490-1, compressible-washer type with plain finish.
- D. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM F3125, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.
1. Finish: Mechanically deposited zinc coating, ASTM B 695, Class 50.
- E. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125, Grade F1852, Type 1, heavy-hex or round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
1. Finish: Plain.
- F. Shear Connectors: ASTM A108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B with dimensions complying with AISC specifications.
- G. Headed Anchor Rods: ASTM F 1554, Grade 55, with supplementary requirement S1, straight.
1. Nuts: ASTM A563 heavy-hex carbon steel.
 2. Plate Washers: ASTM A36 carbon steel.
 3. Washers: ASTM F 436, Type 1, hardened carbon steel.
 4. Finish: Mechanically deposited zinc coating, ASTM B 695, Class 50.

2.3 PRIMER

- A. Structural steel primer paint: SSPC – Paint 11 lead and chromate free, V.O.C. compliant, minimum solids 55% by volume. Use for steel not receiving special coatings or fireproofing or not exposed to weather. Refer to Architectural Drawings and Section 099113 “Exterior Painting,” Section 099123 “Interior Painting,” and Section 099600 “High Performance Coatings.”
1. Provide shop primer and shop applied top coat paint in accordance with Section 099113 “Exterior Painting,” Section 099123 “Interior Painting,” or Section 099600 “High Performance Coatings” where shown on the Architectural Drawings.
 2. Steel permanently exposed to the elements that does not receive a coating, such as cooling tower supports, shall be hot dip galvanized.

2.4 SHRINKAGE-RESISTANT GROUT

- A. Non-metallic shrinkage-resistant grout: Provide in accordance with Section 033000 “Cast-in-Place Concrete.”.

2.5 MISCELLANEOUS

- A. Electrodes for welding: Comply with AWS D1.1-requirements.
 - 1. For complete-joint penetration groove welds, weld metal shall have a charpy V-notch impact strength of 20 ft./lbs. -20°F.

2.6 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.
 - 1. Identify high-strength structural steel according to ASTM A6 and maintain markings until structural steel has been erected.
 - 2. Mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize field handling of materials
 - 3. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
 - 4. Where finishing is required, complete the assembly, including welding before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.
- B. Camber: Camber structural-steel members as indicated on drawings.
 - 1. Where possible, camber of beams shall be applied by a cold bend process. The local application of heat may be used to introduce or correct camber, curvature, or straightness, provided the temperature of the heated area, as measured by temperature crayons or other approved means, does not exceed 1200 F.
 - 2. Where indicated on the Drawings in a camber diagram, cantilever or double cantilever beams shall be cambered for the main span and cantilever end separately, either by a staged cold bending process or by the application of heat.
 - 3. Cambers indicated on the drawings are intended to be final cambers at time of erection. The fabricator shall account for camber loss in the initial camber operations and during transportation of material to the site.
 - 4. Beams and trusses detailed without specified camber shall be fabricated so that after erection any natural camber due to rolling or shop fabrication is upward.
 - 5. Specified camber for beams at time of erection shall be within a tolerance of minus zero to plus one-eighth inch for each ten feet of member length.
 - 6. Specified camber for trusses shall be built into the fabrication process with a tolerance of minus zero to plus 10% of the specified camber.
- C. Architecturally Exposed Structural Steel: Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel identified as architecturally exposed structural steel.
 - 1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, and roughness.
 - 2. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
- D. 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.

- E. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
 - 1. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes, or enlarge holes by burning.
 - 2. Baseplate Holes: Drill holes perpendicular to steel surfaces
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.
- F. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

2.7 CONNECTIONS

- A. Splices in Structural Steel: Splicing of structural steel members in the shop or the field is prohibited without prior approval of the Architect. Any member having a splice not shown and detailed on approved shop drawings will be rejected.
- B. Compression Joints: Compression joints which depend on contact bearing as part of the splice capacity shall have the bearing surfaces of individual fabricated pieces prepared to a common plane by milling, sawing, or other suitable means.
- C. Bearing and Fit-Up of Column Compression Joints: Compression joints of all columns shall have bearing surfaces finished to a common plane by milling, sawing, or other suitable means. Lack of contact bearing must not exceed 1/16", or corrective measures as defined by AISC Section M4.4 shall be required.
- D. Connections:
 - 1. Weld shop connections, as indicated. Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance and quality of welds and for methods used in correcting welding work.
 - 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 - 3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.
 - 4. At welded beam-column flange joints, weld backing and run-off tabs shall be removed and repaired, including a 5/16" reinforcing fillet weld on the edge below the complete-joint-penetration groove weld. The exception that the top-flange backing is permitted to remain if it is attached to the column flange with a continuous fillet weld on the edge below the complete-joint-penetration groove weld.
 - 5. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specifications for Structural Joints using High Strength Bolts" for type of bolt and type of joint specified.
 - 6. Bolt field connections, except where welded connections are indicated.
 - 7. Provide high-strength, threaded fasteners except for temporary bracing to facilitate erection or otherwise indicated.
 - 8. Faying surfaces, including coatings, for slip-critical connections shall have a minimum Class A slip coefficient.
- E. Turn-of-nut method of bolt tightening is not acceptable.
- F. Compression members composed of two or more rolled shapes separated from one another by intermittent fillers shall be connected to one another at such fillers spaced at intervals so that

the least slenderness ratio, l/r , of either shape, between the fasteners, does not exceed the governing slenderness ratio of the built-up member.

- G. Struts and Braces: Connect struts and braces to resist 50% of the allowable tensile strength of the members, unless otherwise specified.
- H. Field Welded Construction: Comply with AWS D1.1 for procedures, appearance and quality of welds, and method used in correcting welding work.
- I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.
- J. Holes for other work: Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on final shop drawings.
- K. Provide weep hole in any confined steel surface capable of retaining water during erection or service. Seal weld as required to prevent migration of water into confined region.

2.8 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
 - 1. Members not exposed to outside elements. Except columns and other steel framing inside parapet walls to be painted.
 - 2. Members or portions of members to be embedded in concrete or mortar. Prime embedded steel that is partially exposed on exposed portions and initial 2" of embedded areas only.
 - 3. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 - 4. Members that are to be hot dip galvanized.
 - 5. Surfaces within 2" of welds.
 - 6. The faying surfaces of slip-critical bolted connections. The exception is for members that receive a coating system. There the faying surfaces should receive a primer providing a Class A surface, with a slip coefficient of 0.33. Submit substantiating data in conformance with Appendix A of the AISC "Specification for Structural Joints".
 - 7. Mask off and do not prime a strip 2" wide on any surfaces to receive a row of headed studs or puddle welds.
- B. Surface Preparation: After inspection and before shipping, clean steel work to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 - 1. SSPC-SP 6, "Commercial Blast Cleaning" for steel to be painted or receive a coating
 - 2. SSPC-SP 2, "Hand Tool Cleaning," or SSPC-SP 3, "Power Tool Cleaning" for all other conditions.
- C. Priming: Unless specified otherwise in Section 099113 "Exterior Painting" or Section 099123 "Interior Painting," 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 2.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces. Refer to Section 099600 "High Performance Coatings" for priming and painting members to receive special coatings.

- D. Steel members which cannot be readily painted after fabrication, such as back-to-back angles and tees, shall be primed and finish coated, or receive two coats of primer, prior to fabrication.
- E. Do not print or emboss the name of the fabricator on exposed steel unless it is completely concealed by the finish painting.

2.9 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel members permanently exposed to the elements, such as cooling tower support steel, according to ASTM A123.
 - 1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
 - 2. Galvanize mechanical equipment support steel, lintels, and shelf angles attached to structural-steel frame and located in exterior walls.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, bearing pads, and other embedments for compliance with requirements.
 - 1. Surveys: Employ a Florida Licensed Engineer or Land Surveyor for accurate erection of structural steel. Check elevations of concrete and masonry bearing surfaces and locations of anchor bolts and similar devices, before erection work proceeds, and report discrepancies to Architect. Do not proceed with erection until corrections have been made, or until compensating adjustments to structural steel work have been agreed upon with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Temporary shoring and bracing: Provide temporary shoring and bracing members and connections of sufficient strength to bear imposed loads from steel self weight and erection procedures or any other loads created by other contractors on a temporary basis. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guidelines to achieve proper alignment of structures as erection proceeds.
 - 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.
- B. Temporary planking: Provide temporary planking and working platforms as necessary to effectively complete work.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Baseplates and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of baseplate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 4. Promptly pack grout solidly between bearing surfaces and base 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.
 - 5. Base plates must be grouted a minimum of 72 hours prior to placing concrete slabs on supporting steel structure.
- C. Anchor rods and bolts: Furnish anchor rods, bolts and other connectors required for securing structural steel to foundations and other in-place work.
 - 1. Furnish templates and other devices as necessary for pre-setting rods, bolts and other anchors to accurate locations.
 - 2. Refer to Section 3 of these specifications for anchor rod installation requirements in concrete, and Section 4 for masonry installation.
- D. Maintain erection tolerances of structural steel and architecturally exposed structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- E. Field assembly: Set structural members accurately to lines and elevations indicated. Align and adjust various members forming a part of a complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces which will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment. Comply with AISC Code of Standard Practice except where more stringent requirements are contained herein.
 - 1. Level and plumb individual members of structure within specified AISC tolerances.
 - 2. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.
- F. Erection bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces.
- G. Comply with AISC Specification for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
- H. Splice members only where indicated and accepted on shop drawings.
- I. Thermal cutting: Do not use gas-cutting torches in field for correcting fabrication errors in primary structural framing. When permitted, finish gas-cut sections equal to a sheared appearance by grinding or reaming. Do not use gas cutting to fabricate bolt holes.

- J. Do not enlarge unfair holes in members by burning or by use of drift pins. Ream holes that must be enlarged to admit bolts as permitted by Architect.
- K. Headed shear studs: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions. All welding ferrules for shear connectors shall be removed prior to placement of concrete.

3.4 FIELD CONNECTIONS

- A. Store fastener components in sealed containers until ready for use. Reseal open containers to prevent contamination by moisture or other deleterious substances. Store closed containers from dirt and moisture in a protective shelter. Take from protective storage only as many fastener components as are anticipated to be installed during the work shift. Fastener components that are not incorporated into the work shall be returned to protective storage at the end of the work shift. Fasteners from open containers and fasteners that accumulate rust or dirt shall not be used and shall be immediately and permanently removed from the project site.
- B. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using High Strength Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
- C. Tighten bearing-type bolts (GR A325N, GR A325X, GR A490N, and GR A490X) to the snug tight condition as follows:
 - 1. Bolts shall be placed in all holes, with washers positioned as required and nuts threaded to complete the assembly.
 - 2. Compacting the joint to the snug-tight condition shall progress systematically from the most rigid part of the joint.
 - 3. The snug-tightened condition is the tightness that is attained with a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench.
 - 4. More than one cycle through the bolt pattern may be required to achieve the snug-tightened joint.
- D. Tighten slip-critical bolts (GR A325SC, GR A325TC, GR A490SC, and GR A490TC) to the minimum fastener tension indicated in Table 8.1 of the "Specification for Structural Joints using High Strength Bolts" as follows:
 - 1. Confirm with Architect on which face of the connection the round head of the TC bolt shall be located for exposed connections.
 - 2. Begin final tightening of slip-critical bolts only after a snug-tight joint as described above is achieved. Progress systematically from the most rigid part of the joint.
 - 3. If splined end of tension-control bolts is severed prior to achieving snug-tight joint, remove and replace the fastener assembly.
 - 4. Progress systematically from the most rigid part of the joint in a manner that will minimize relaxation of previously pretensioned bolts.
 - 5. Determine tension using either load indicator washers, tension-control bolts, or a calibrated torque wrench.
- E. Provide hardened washers conforming to ASTM F436 and place under the part being turned.

- F. Do not reuse or retighten bolts which have been fully tightened. Use only non-galvanized nuts and bolts that are clean, rust-free, and well lubricated. Bolts and nuts shall be wax dipped by the bolt supplier or lubricated with Castrol Industrial Stick Wax.
- G. Cleaning and lubrication of ASTM F3125, GR F1852 and GR F2280 twist-off-type tension-control bolt assemblies is not permitted.
- H. Where slotted holes are used to accommodate thermal movement, notify the Architect if bolt is expected to hit the end of slot, based on temperature at time of installation.
- I. Weld Connections: Comply with AWS D1.1 for tolerances, appearances, welding procedure specifications, weld quality, and for 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, back gouge, and grind steel smooth.
 - 3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.
- J. Protect bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.

3.5 QUALITY CONTROL

- A. Shop Quality Control:
 - 1. The Fabricator shall provide a system of quality control, including shop welding inspections and testing, to ensure that the minimum standards specified herein are attained. Submit to Owner, Architect, Engineer and Owner's Testing and Inspection Agency complete details of the quality control program to be used and all testing and inspection reports. Visually inspect 100% of shop welds. Also, as a minimum, perform non-destructive tests of welds in conformance with AWS D1.1 as follows:
 - a. Splices: 100%.
 - b. Full penetration welds: 100%.
 - c. Partial penetration welds: 50%.
 - d. Fillet welds: 5%.
 - 2. The fabricator may use the following examination methods, in descending order of importance. When a particular examination method for a joint is unfeasible, the highest order method that is practicable shall be used. Standard of acceptance shall be in accordance with AWS D1.1.
 - a. Ultrasonic Method: In accordance with AWS D1.1.
 - b. Radiographic Method: In accordance with ASTM E94 and ASTM E142, with a minimum quality level of "2-2T". This procedure is limited to the inspection of groove welds in butt joints only and is not to be used for fillet welds.
 - c. Magnetic Particle Method: In accordance with ASTM E709. Use for examining partial penetration welds. Percentage of examinations is defined elsewhere in these specifications. The Yoke method may be used only for supplementary surface examination.

- d. Dye Penetrant Examination Method: In accordance with ASTM E165.
 3. The Fabricator shall ultrasonically inspect for laminations all joints where material is subjected to tension in the through thickness direction. Ultrasonic inspection shall extend for a distance of six times the material thickness subject to the through thickness tension, either side of the element delivering the tension.
- B. Contractor will engage a Structural Inspector, acceptable to the Owner, to perform field inspections.
 - C. Testing agency shall conduct and interpret tests and state in each report whether test specimens comply with requirements, and specifically state any deviations therefrom.
 - D. Provide access for testing agency to places where structural steel work is being fabricated or produced and unobstructed views to all members in nearby storage so that required inspection and testing can be accomplished.
 - E. Testing agency may inspect structural steel at plant before shipment; however, Architect reserves the right, at any time before final acceptance, to reject material not complying with specified requirement.
 - F. Correct deficiencies in structural steel work which inspections or laboratory test reports have indicated to be not in compliance with requirements. Perform additional tests, at Contractor's expense, as may be necessary to reconfirm any noncompliance of original work, and as may be necessary to show compliance of corrected work.
 - G. Shop Inspection and Tests: Testing Agency may inspect and test during fabrication of structural steel assemblies, as follows:
 1. Review shop drawings and shop procedures with Fabricator's supervisory personnel.
 2. Request and obtain necessary mill certifications of steel and verify proper material throughout the duration of the job.
 3. Verify welding procedure qualifications, either by prequalifications or by witnessing qualification tests.
 4. Verify welder qualifications, either by certification and/or by retesting. Obtain welder certificates.
 5. Spot check layout and dimensions of jigs and fixtures for joint preparation, and fit up of members.
 6. Verify welding electrodes to be used and other welding consumables as the job progresses.
 7. Check preheating procedures for conformance to AWS D1.1.
 8. Verify procedures for welding in accordance with applicable portions of section 4, "Technique", AWS D1.1.
 9. Verify that quality of welds meet the requirements of Paragraph B.15, "Quality of Welds", AWS D1.1.
 10. Provide inspection of surface preparation for coating and coating operations in accordance with SSPC VIS 1 and 2.
 11. Perform visual inspection of all welds for compliance with Contract Documents. Provide random non-destructive tests of welds in conformance with Section 6 of AWS D1.1, as may be required by Architect, but not less than:
 - a. Full penetration welds: 25%.
 - b. Partial penetration welds: 15%.
 - c. Fillet Welds: 5%.

12. Testing laboratory may use the following examination methods, in descending order of importance. When a particular examination method for a joint is unfeasible, the highest order method that is practicable shall be used. Standard of acceptance shall be in accordance with AWS D1.1.
 - a. Ultrasonic Method: In accordance with AWS D1.1.
 - b. Radiographic Method: In accordance with ASTM E94 and ASTM E142, with a minimum quality level of "2-2T". This procedure is limited to the inspection of groove welds in butt joints only and is not to be used for fillet welds.
 - c. Magnetic Particle Method: In accordance with ASTM E709. Use for examining partial penetration welds. Percentage of examinations is defined elsewhere in these specifications. The Yoke method may be used only for supplementary surface examination.
 - d. Dye Penetrant Examination Method: In accordance with ASTM E165.
 13. Ultrasonically inspect for laminations after welding all joints with rolled shapes and plates greater than 1 1/2" thick, where material is subjected to tension in the through thickness direction. The ultrasonic inspection shall extend for a distance of six times the thickness of the plate receiving the through thickness tension, either side of the plate delivering the tension.
 14. Interpret, record, and report all results of the non-destructive tests.
 15. Mark for repair, any area not meeting Specification requirements. Correction of rejected welds shall be made in accordance with Paragraph 5.26, "Repairs", AWS D1.1
 16. Re-examine all repair areas and interpret, record, and report the results of examinations of repair welds.
- H. Field Inspection and Tests: Inspect and Test during the erection of structural steel assemblies as directed by the Engineer of Record, but not less than the following:
1. Verify field welding procedures and obtain welder certificates.
 2. Check joint preparation and fit up, backing strips, and runout plates.
 3. Check preheating to assure proper temperature, uniformity, and thoroughness through the full material thickness.
 4. Review welding sequence.
 5. Inspector shall perform visual inspection of all welds for compliance with Contract Documents. Testing Agency shall perform non-destructive tests of welds in conformance with Section 6 of AWS D1.1 as may be required by Architect, but not less than:
 - a. Splices: 100%.
 - b. Full Penetration Welds: 100%.
 - c. Partial Penetration Welds: 50%.
 - d. Fillet Welds: All welds that do not pass the visual inspection.
 6. Check 100% of bolted connections according to inspection procedures outlined in the "Specification for Structural Joints using High Strength Bolts" and as required elsewhere in these specifications.
 7. Production Stud Application Testing: Test the first two studs per welder per day for each set-up and size and type of stud. Test by bending studs 30 degrees using a 4 lb. hammer per AWS D1.1 Section 7.7. Use a 4 lb. hammer to sound 100% of studs. A pinging sound usually represents a sound weld. Studs that produce a "thud" should be bend tested. Passing studs may remain bent while failing studs must be replaced.
 8. Interpret, record, and report all results of the non-destructive tests.
 9. Mark for repair any area not meeting Specification requirements. Correction of rejected welds shall be made in accordance with Paragraph 5.26, "Repairs", AWS D1.1.
 10. Re-examine all repair areas and interpret, record, and report the results of examinations of repair welds.

- I. Pre-installation testing of as-received fastener assemblies shall be performed according to the Specifications for Structural Joints using High Strength Bolts, Section 7 and as follows:
 1. Tension Calibrator (a hydraulic device that indicates the pretension that is developed in a bolt that is installed in it) shall be provided by the testing agency, at the Project Site, to confirm the tension force in the fastener assembly.
 2. A sample of not fewer than three complete fastener assemblies from each shipping container shall be checked at the site.
 3. Fastener assemblies tested shall develop a pretension force not less than 1.05 times that required by Table 8.1 in AISC. Minimum passing test force: A325: 3/4"=29.4 kips, 7/8"=41.0 kips, 1"=53.6 kips; A490: 3/4"=36.8 kips, 7/8"=51.4 kips, 1"=67.2 kips.

3.6 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A780.
 1. Apply Zinc-Clad Cold Galvanizing by Sherwin-Williams or Cold Galvanizing Compound by ZRC Worldwide by brush or spray to provide a minimum dry film thickness of 3 mils.
- B. Touchup Painting: Immediately after erection, clean slag from field welds, clean bolted connections, and abraded areas of shop paint. Apply paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Touchup Priming: For steel having special coatings system, reapply both primer and top coat as specified in Section 099600 "High-Performance Coatings."

END OF SECTION 051200

SECTION 053100

STEEL DECK

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. Roof deck.
 - 2. Composite floor deck.
- B. Related Sections include the following:
 - 1. Section 033000 "Cast-in-Place Concrete" for concrete fill over steel deck
 - 2. Section 035216 "Lightweight Insulating Concrete" for lightweight insulating concrete fill over steel deck
 - 3. Section 051200 "Structural Steel Framing" for shop and field welded shear connectors.
 - 4. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated, or requested by the Architect.
- B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding Certificates: Copies of certificates for welding procedures and personnel. Submit to general contractor and Special Inspector.
- B. Product Certificates: Signed by steel deck manufacturers certifying that products furnished comply with requirements.
- C. Product Test Reports: Based on evaluations of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
 - 1. Power-actuated mechanical fasteners.

- D. Research Reports: For steel deck, from ICC-ES.
- E. Field quality-control test and inspection reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E329 to conduct the testing indicated, as documented according to ASTM E548.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel," and AWS D1.3, "Structural Welding Code - Sheet Steel."
- C. Manufacturer Qualifications: Member of the Steel Deck Institute.
- D. Installer Qualifications: An experienced installer who has completed steel deck installations similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- E. Fabrication and Erection: Fabricate and erect deck per the Steel Deck Institute's "Design Manual for Composite Decks, Form Decks and Roof Decks".
 - 1. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
- F. Codes and Standards: Comply with Florida Building Code, 7th Edition.

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 E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.2 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Steel Deck:
 - a. Canam Steel Corporation: Canam Group Inc.
 - b. Coredeck
 - c. DACS, Inc.
 - d. Epic Metals Corporation.
 - e. Marlyn Steel Decks, Inc.
 - f. New Millennium Building Systems, LLC
 - g. Nucor Corporation.
 - h. Nucor Corporation, Verco Group
 - i. Roof Deck, Inc.

2.3 ROOF DECK

- A. Steel 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 the following:
1. Galvanized Steel Sheet: ASTM A653, Structural Steel (SS), Grade 40 [80], G90 zinc coating.
 2. Deck Profile; Depth and Design Uncoated-Steel Thickness: As indicated on Drawings.
 3. Span Condition: Triple span typical, double span minimum, U.O.N. on Drawings.
 4. Side Laps: Overlapped.

2.4 COMPOSITE FLOOR DECK

- A. Composite Steel 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, the minimum section properties indicated, and the following:
1. Galvanized Steel Sheet: ASTM A653, Structural Steel (SS), Grade 40, G60 and G90 zinc coating as indicated on plans.
 2. Shear Lugs (Web Embossments): 0.050 inch high (min.).
 3. Profile Depth and Design Uncoated-Steel Thickness: As indicated on Drawings.
 4. Span Condition: Triple span typical, double span minimum, U.O.N. on Drawings.

2.5 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Steel Sheet Accessories: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
- G. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth unless otherwise indicated.
- H. Column Closures, End Closures, Z-Closures, and Cover Plates:
 - 1. Epicore Metals Corporation: Sheet steel of same material and finish, 10 gauge or less, unless otherwise indicated.
 - 2. All others: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
- I. Provide recessed or flat sump pan in accordance with roof drain requirements. Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. Recessed sump pans shall have with 3-inch wide flanges and be leveled recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.
- J. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight. Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Galvacon Cold Galvanizing Compound: Lanco Inc.
 - 2. ZRC Cold Galvanizing Compound: ZRC Worldwide, Inc.

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.

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. Deck has been designed to span unshored, U.O.N. on Drawings.
- 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 decking.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may not be used in lieu of welding to fasten deck unless specifically allowed by the local product approval for the roofing system and approved by the Engineer of Record. Provide mechanical fasteners according to deck manufacturer's written instructions and per the Structural Notes on the Drawings.

3.3 ROOF DECK INSTALLATION

- A. Fasten roof deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated as follows:
 - 1. Weld Diameter: As indicated on the Drawings.
 - 2. Weld Spacing: Weld deck units as indicated on the Drawings.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, as indicated on the Drawings.
 - 1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
 - 1. End Joints: Lapped 2 inches minimum.
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof decking and weld flanges to top of deck. Space welds not more than 12 inches apart with at least 1 weld at each corner.
 - 1. Install reinforcing channels or zees in ribs to span between supports and mechanically fasten.
- E. Miscellaneous Roof Deck Accessories: Install ridge and valley plates, finish strips, cover plates, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.
- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated at non-fire-resistance-rated partitions. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

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 on the Drawings.
 2. Weld Spacing: Space and locate welds as indicated on the drawings.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, as indicated on the Drawings.
1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
1. End Joints: Butted at composite floor deck and lapped or butted at noncomposite form deck.
- 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 decking. Weld cover plates at changes in direction of floor deck panels, unless otherwise indicated.

3.5 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.
- B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

3.6 FIELD QUALITY CONTROL

- A. Testing: Contractor will engage a qualified independent testing agency, acceptable to the Owner, to perform field quality-control testing.
- B. Field welds will be subject to inspection.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Remove and replace work that does not comply with specified requirements.
- E. Additional testing and/or inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.
- F. Testing agency to send reports directly to the Architect and Engineer at the same time as provided to Contractor.

END OF SECTION 053100

SECTION 054000

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Exterior non-load-bearing wall framing.
 - 2. Soffit framing.
- B. Related Requirements:
 - 1. Section 033000 "Cast-In-Place Concrete."
 - 2. Section 055000 "Metal Fabrications".
 - 3. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies.
 - 4. Section 092216 "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data and Installation Instructions: For each type of cold-formed steel framing product and accessory, including fasteners, materials, and finishes.
- B. Shop Drawings:
 - 1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
 - 2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
 - a. For cold-formed metal framing indicated to comply with design loads, shop drawings and calculations shall be signed and sealed by the delegated (specialty) engineer responsible for their preparation.
- C. Delegated-Design Submittal: For cold-formed steel framing.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project

name and addresses, names and addresses of architects and owners, and other information specified.

- B. Welding certificates.
- C. Product Test Reports: For each listed product, for tests performed by a qualified testing agency.
 - 1. Steel sheet.
 - 2. Expansion anchors.
 - 3. Power-actuated anchors.
 - 4. Mechanical fasteners.
 - 5. Vertical deflection clips.
 - 6. Horizontal drift deflection clips
 - 7. Miscellaneous structural clips and accessories.
- D. Research Reports: For non-standard cold-formed steel framing, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- B. Qualifications:
 - 1. Fabricator Qualifications: Company with not less than five (5) documented satisfactory experiences designing and fabricating cold-formed steel framing systems equal in material, design and extent to the systems required for this Project.
 - 2. Installer Qualifications: An experienced installer who has completed cold-formed metal framing similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- D. Engineering Responsibility: Engage a delegated licensed engineer to prepare design calculations, Shop Drawings, and other structural data.
- E. Delegated Engineer: A licensed engineer who is legally qualified to practice in State of Florida 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.
- F. Codes and Standards: Comply with the following, unless more stringent provisions are indicated:
 - 1. Florida Building Code, 7th Edition.
 - 2. ASCE 7, "Minimum Design Loads for Buildings and Other Structures."
 - 3. AWS D1.1, "Structural Welding Code - Steel."
 - 4. AWS D1.3, "Structural Welding Code - Sheet Steel."

See "Performance Requirements" for additional codes and standards.

1.6 FIELD MEASUREMENTS

- A. Verify all dimensions and conditions by field measurement. Indicate and flag on shop drawings all discrepancies between actual conditions and contract documents.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's unopened containers or bundles, fully identified by manufacturer's name, job number, and member number. Exercise care to avoid damage during unloading, storing and erection.
- B. Store framing members on blocking, pallets, platforms or other supports off the ground, sufficiently braced to avoid damage from excessive bending.
- C. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

1.8 PROJECT CONDITIONS

- A. During construction, adequately distribute all loads applied to member so as not to exceed the carrying capacity of any framing member.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AllSteel & Gypsum Products, Inc.
 - 2. ClarkWestern Building Systems, Inc.
 - 3. Consolidated Fabricators Corp.; Building Products Division.
 - 4. Craco Mfg., Inc.
 - 5. Dietrich Metal Framing; a Worthington Industries Company.
 - 6. MarinoWARE.
 - 7. Nuconsteel; a Nucor Company.
 - 8. SCAFCO Corporation.
 - 9. Southeastern Stud & Components, Inc.
 - 10. Steel Construction Systems.
 - 11. Steel Network, Inc. (The).
 - 12. Steel Structural Systems.
 - 13. Super Stud Building Products, Inc.
 - 14. Telling Industries, LLC.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.
- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
 - 1. Design Loads: As indicated on drawings or required by Code.
 - 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/240 of the wall height.
 - b. Soffit Framing: Vertical deflection of 1/240 of the horizontally projected span for live loads.
 - 3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
 - 4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of 3/4 inch.
 - 5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
- C. Cold-Formed Steel Framing Design Standards:
 - 1. Floor and Roof Systems: AISI S210.
 - 2. Wall Studs: AISI S211.
 - 3. Headers: AISI S212.
 - 4. Lateral Design: AISI S213.
- D. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.
- E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.3 COLD-FORMED STEEL FRAMING, GENERAL

- A. Steel Sheet: ASTM A 1003, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
 - 1. Grade: As required by structural performance.
 - 2. Coating: G60.

- B. Steel Sheet for Vertical Deflection Drift Clips: ASTM A 653, structural steel, zinc coated, of grade and coating as follows:
 - 1. Grade: As required by structural performance.
 - 2. Coating: G60.

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch.
 - 2. Minimum Flange Width: 1-5/8 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: Matching steel studs.
 - 2. Minimum Flange Width: 1-1/4 inches.
- C. Vertical Deflection Clips: Manufacturer's standard bypass and/or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
 - 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. AllSteel & Gypsum Products, Inc.
 - b. ClarkWestern Building Systems, Inc.
 - c. Dietrich Metal Framing; a Worthington Industries company.
 - d. MarinoWARE.
 - e. Steel Network, Inc. (The).
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - 1. Minimum Base-Metal Thickness: Matching steel studs
 - 2. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.
- E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.
 - 1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - a. Minimum Base-Metal Thickness: Matching steel studs.
 - b. Minimum Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.

2. Inner Track: Of web depth indicated, and as follows:
 - a. Minimum Base-Metal Thickness: Matching steel studs.
 - b. Flange Width: Dimension equal to sum of outer deflection track flange width plus 1 inch.

- F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.5 SOFFIT FRAMING

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

2.6 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003, 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 and knee braces.
 9. Joist hangers and end closures.
 10. Hole reinforcing plates.
 11. Backer plates.

2.7 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36, zinc coated by hot-dip process according to ASTM A 123.

- B. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.

- C. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

- D. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.
- E. Welding Electrodes: Comply with AWS standards.

2.8 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B.
- B. Shims: Load bearing, high-density multimonomer plastic, and nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.
- C. 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.

2.9 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
 - 2. Cut framing members by sawing or shearing; do not torch cut.
 - 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
 - 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

- F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Install insulation, specified in Section 072100 "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- H. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.
- I. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: 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. Install single deep-leg deflection tracks and anchor to building structure.
 - 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
 - 3. Connect vertical deflection clips to bypassing studs and anchor to building structure.
 - 4. Connect drift clips to cold-formed metal framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
 - 1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
 - a. Install solid blocking at centers indicated on Shop Drawings.
 - 2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 - 3. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.

- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 JOIST INSTALLATION (Soffits)

- A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.
- B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
 - 1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
 - 2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.
- C. Space joists not more than 2 inches from abutting walls, and as follows:
 - 1. Joist Spacing: As required by soffit panel system.
- D. Frame openings with built-up joist headers consisting of joist and joist track, or another combination of connected joists if indicated.
- E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated on Shop Drawings.
 - 1. Install web stiffeners to transfer axial loads of walls above.
- F. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:
 - 1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to bottom flange of joists.
 - 2. Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
 - 3. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.
- G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.
- H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.6 FIELD QUALITY CONTROL

- A. Inspection: Contractor will engage a qualified inspection agency, acceptable to the Owner, to perform inspections.
- B. Field and shop welds will be subject to inspection.

- C. Remove and replace work that does not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- E. Testing agency to send reports directly to the Architect and Engineer at the same time as provided to Contractor.

3.7 REPAIRS AND PROTECTION

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

END OF SECTION 054000

**SECTION 055000
METAL FABRICATIONS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Shop fabricated steel and aluminum items.
- B. Prefabricated ladders and rails.

1.02 REFERENCE STANDARDS

- A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum 2014 (2015 Errata).
- B. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements 2018.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2020.
- E. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- F. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- G. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates 2018.
- H. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing 2021.
- I. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- J. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength 2018a.
- K. ASTM B211 - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire 2012.
- L. ASTM B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold-Finished Bar, Rod, and Wire (Metric) 2012.
- M. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength 2019, with Editorial Revision (2020).
- N. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination 2012.
- O. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020.
- P. AWS D1.2/D1.2M - Structural Welding Code - Aluminum 2014, with Errata.
- Q. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel 2018.
- R. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer 1999 (Ed. 2004).
- S. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic") 2002 (Ed. 2004).
- T. SSPC-SP 2 - Hand Tool Cleaning 2018.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.

1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- C. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.
- D. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is accredited under IAS AC172.

1.04 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified steel fabricator that is accredited by IAS AC172.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A501/A501M hot-formed structural tubing.
- C. Plates: ASTM A283/A283M.
- D. Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.
- E. Slotted Channel Framing: ASTM A653/A653M, Grade 33.
- F. Slotted Channel Fittings: ASTM A1011/A1011M.
- G. Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, plain.
- H. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- I. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- J. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.02 MATERIALS - ALUMINUM

- A. Aluminum-Alloy Bars: ASTM B211 (ASTM B211M), 6061 alloy , T6 temper.
- B. Bolts, Nuts, and Washers: Stainless steel.
- C. Welding Materials: AWS D1.2/D1.2M; type required for materials being welded.

2.03 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- D. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.04 FABRICATED ITEMS

- A. Ladders: Steel; in compliance with ANSI A14.3; with mounting brackets and attachments; galvanized finish.
 1. Side Rails: 3/8 x 2 inches members spaced at 20 inches.
 2. Rungs: one inch diameter solid round bar spaced 12 inches on center.
 3. Space rungs 7 inches from wall surface.
 4. Provide a lockable ladder access prevention system.
- B. Bollards: Galvanized steel.
- C. Lintels: As detailed; galvanized finish.
- D. Sill Angles for Tempered Glass Railing Assemblies: ASTM A36/A36M steel angles with anchoring devices and sizes as indicated in shop drawings for railing assembly, drilled and

tapped for fastener types, sizes, and spacing indicated, prime paint finish.

- E. Door Frames for Overhead Door Openings: Channel sections; prime paint finish.
- F. Elevator Hoistway Divider Beams: Beam sections; prime paint finish.

2.05 FINISHES - STEEL

- A. Prime paint steel items.
 - 1. Exceptions: Galvanize items specified for galvanized finish.
 - 2. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required.
 - 3. Exception: Do not paint items in drawings with "Blackened Steel" finish designation.
- B. Prepare surfaces to be primed in accordance with SSPC-SP2.
- C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- D. Prime Painting: One coat.
- E. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A123/A123M requirements. Provide minimum 1.7 oz/sq ft galvanized coating.

2.06 FINISHES - ALUMINUM

- A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.

2.07 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch.
- C. Maximum Misalignment of Adjacent Members: 1/16 inch.
- D. Maximum Bow: 1/8 inch in 48 inches.
- E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.

3.03 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Field weld components as indicated on drawings.
- D. Perform field welding in accordance with AWS D1.1/D1.1M.
- E. Obtain approval prior to site cutting or making adjustments not scheduled.
- F. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION 055000

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**SECTION 055100
METAL STAIRS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Stairs with concrete treads.
- B. Structural steel stair framing and supports.
- C. Handrails and guards.
- D. Prefabricated stair treads and nosings.

1.02 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- B. AISC 201 - AISC Certification Program for Structural Steel Fabricators, Standard for Steel Building Structures 2006.
- C. ASTM A6/A6M - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling 2019.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2020.
- F. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes 2021a.
- G. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing 2021.
- H. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable 2021.
- I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength 2018a.
- J. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength 2019, with Editorial Revision (2020).
- K. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination 2012.
- L. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020.
- M. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer 1999 (Ed. 2004).
- N. SSPC-SP 2 - Hand Tool Cleaning 2018.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
 - 2. Include the design engineer's seal and signature on each sheet of shop drawings.
- C. Design Data: As required by authorities having jurisdiction.
- D. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is certified under AISC 201.

1.04 QUALITY ASSURANCE

- A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located, or personnel under direct supervision of such an engineer.
- B. Fabricator Qualifications:
 - 1. A qualified steel fabricator that is certified by the American Institute for Steel Construction (AISC) under AISC 201.

PART 2 PRODUCTS

2.01 METAL STAIRS - GENERAL

- A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.
 - 1. Regulatory Requirements: Provide stairs and railings that comply with most stringent requirements of local, state, and federal regulations; where requirements of Contract Documents exceed those of regulations, comply with Contract Documents.
 - 2. Handrails: Comply with applicable accessibility requirements of ADA Standards.
 - 3. Structural Design: Provide complete stair and railing assemblies that comply with the applicable local code.
 - 4. Dimensions: As indicated on drawings.
 - 5. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
 - 6. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
 - 7. Separate dissimilar metals using paint or permanent tape.
- B. Metal Jointing and Finish Quality Levels:
 - 1. Architectural: All joints as inconspicuous as possible, whether welded or mechanical.
 - a. Welded Joints: Continuously welded and ground smooth and flush.
 - b. Mechanical Joints: Butted tight, flush, and hairline; concealed fastenings only.
 - c. Exposed Edges and Corners: Eased to small uniform radius.
 - d. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for highest quality gloss finish.
- C. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.
- D. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.02 METAL STAIRS WITH CONCRETE TREADS

- A. Jointing and Finish Quality Level: Architectural, as defined above.
- B. Risers: Closed.
- C. Treads: Metal pan with field-installed concrete fill.
 - 1. Concrete Depth: 1-1/2 inches, minimum.
 - 2. Tread Pan Material: Steel sheet.
 - 3. Tread Pan Thickness: As required by design; 14 gauge, 0.075 inch minimum.
 - 4. Pan Anchorage to Stringers: Welded to carrier angles welded to stringers.
 - 5. Concrete Reinforcement: Welded wire mesh.
 - 6. Concrete Finish: Steel troweled.
- D. Risers: Same material and thickness as tread pans.
 - 1. Riser/Nosing Profile: Vertical riser with underside of nosing sloped up from bottom of tread pan at not less than 60 degrees from horizontal, with rounded top of nosing of minimum radius.
 - 2. Nosing Depth: Not more than 1 inch overhang.
 - 3. Nosing Return: Flush with top of concrete fill, not more than 1/2 inch wide.
- E. Stringers: Rolled steel channels.

1. Stringer Depth: As indicated on drawings.
 2. End Closure: Sheet steel of same thickness as risers welded across ends.
- F. Landings: Similar construction, using corrugated steel decking, supported and reinforced as required to achieve design load capacity.
- G. Railings: Steel mesh railings.
- H. Finish: Shop- or factory-prime painted.
- I. Under Side of Stair: Exposed to view, to be finished same as specified for other exposed to view surfaces unless noted otherwise in drawings.

2.03 HANDRAILS AND GUARDS

- A. Wall-Mounted Rails: Round pipe or tube rails unless otherwise indicated.
1. Outside Diameter: 1-1/2 inches.
- B. Guards:
1. Top Rails: Round pipe or tube rails unless otherwise indicated.
 - a. Outside Diameter: 1-1/2 inches.
 2. Infill at Mesh Railings: Woven wire mesh panels.
 - a. Material and Finish: Same as stair.
 - b. Wire Size: 3/16" inch.
 - c. Wire Spacing: 3" inch.
 - d. Mounting: Mesh welded to steel bar frame, frame welded to posts.
 3. End and Intermediate Posts: Same material and size as top rails.
 - a. Horizontal Spacing: As indicated on drawings.
 - b. Mounting: Welded to top surface of stringer.

2.04 MATERIALS

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A500/A500M or ASTM A501/A501M structural tubing, round and shapes as indicated.
- C. Steel Plates: ASTM A6/A6M or ASTM A283/A283M.
- D. Pipe: ASTM A53/A53M Grade B Schedule 40, black finish.
- E. Ungalvanized Steel Sheet: Hot- or cold-rolled, except use cold-rolled where finished work will be exposed to view.
 1. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Designation CS (commercial steel).
 2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Designation CS (commercial steel).
- F. Concrete Fill: Portland cement Type I, 3000 psi 28 day strength, 2 to 3 inch slump.
- G. Concrete Reinforcement: Mesh type as detailed, galvanized.

2.05 ACCESSORIES

- A. Steel Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, and galvanized to ASTM A153/A153M where connecting galvanized components.
- B. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- C. Shop and Touch-Up Primer: SSPC-Paint 15, and comply with VOC limitations of authorities having jurisdiction.

2.06 SHOP FINISHING

- A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- B. Do not prime surfaces in direct contact with concrete or where field welding is required.
- C. Prime Painting: Use specified shop- and touch-up primer.
 1. Preparation of Steel: In accordance with SSPC-SP 2 Hand Tool Cleaning.
 2. Number of Coats: One.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. When field welding is required, clean and strip primed steel items to bare metal.
- B. Supply items required to be cast into concrete and embedded in masonry with setting templates.

3.03 INSTALLATION

- A. Install components plumb and level, accurately fitted, free from distortion or defects.
- B. Provide anchors, plates, angles, hangers, and struts required for connecting stairs to structure.
- C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- D. Provide welded field joints where specifically indicated on drawings. Perform field welding in accordance with AWS D1.1/D1.1M.
- E. Other field joints may be either welded or bolted provided the result complies with the limitations specified for jointing quality levels.
- F. Obtain approval prior to site cutting or creating adjustments not scheduled.
- G. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.

END OF SECTION 055100

**SECTION 055213
PIPE AND TUBE RAILINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Stair railings and guardrails.
- B. Free-standing railings at ramps.
- C. Free-standing railings at steps.

1.02 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Placement of anchors in concrete.
- B. Section 042000 - Unit Masonry: Placement of anchors in masonry.
- C. Section 055100 - Metal Stairs: Handrails other than those specified in this section.

1.03 REFERENCE STANDARDS

- A. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix) 2017a.
- B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- C. ASTM A204/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strips for pressure vessels and for general applications; 2015b.
- D. ASTM B241/B241M - Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube 2016.
- E. ASTM B429/B429M - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube 2020.
- F. ASTM B483/B483M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Tubes for General Purpose Applications 2020.
- G. ASTM E935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings 2021.
- H. ASTM E985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings 2000 (Reapproved 2006).

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

PART 2 PRODUCTS

2.01 RAILINGS - GENERAL REQUIREMENTS

- A. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of ASTM E985 and applicable local code.
- B. Distributed Loads: Design railing assembly, wall rails, and attachments to resist distributed force of 75 pounds per linear foot applied to the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935
- C. Concentrated Loads: Design railing assembly, wall rails, and attachments to resist a concentrated force of 200 pounds applied at any point on the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935
- D. Dimensions: See drawings for configurations and heights.
- E. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.

1. For anchorage to concrete, provide inserts to be cast into concrete, for welding anchors.
2. For anchorage to masonry, provide brackets to be embedded in masonry, for welding anchors.

2.02 EXTERIOR HANDRAILS AND GUARDRAILS

- A. Aluminum Tube: Minimum wall thickness of .25 inch; ASTM B429/B429M, ASTM B241/B241M, or ASTM B483/B483M.
- B. Solid Bars and Flats: ASTM B211 (ASTM B211M).
- C. Welding Fittings: No exposed fasteners; machined aluminum.
- D. Straight Splice Connectors: Concealed spigot; cast aluminum.
- E. Exposed Fasteners: No exposed bolts or screws.
- F. Surface cleaning: Aluminum surfaces must be clean and free of oil and grease before finish coating applied.
- G. Surface Preparation: Remove surface aluminum oxide by sweep blasting or phosphate treatment. Apply chemical pretreatment of surface (such as application of phosphoric acid) prior to powder coating to promote adhesion.

2.03 FABRICATION

- A. Accurately form components to suit specific project conditions and for proper connection to building structure.
- B. Fit and shop assemble components in largest practical sizes for delivery to site.
- C. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.
- D. Welded Joints:
 1. Exterior Components: Continuously seal joined pieces by intermittent welds and plastic filler. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion.
 2. Interior Components: Continuously seal joined pieces by intermittent welds and plastic filler.
 3. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

2.04 ALUMINUM FINISHES

- A. High Performance Organic Coating System: AAMA 2604 multiple coat, thermally cured fluoropolymer system.
- B. Color: To be selected by Architect from manufacturer's full line.
- C. Touch-Up Materials: As recommended by coating manufacturer for field application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply items required to be cast into concrete or embedded in masonry with setting templates, for installation as work of other sections.
- C. Apply one coat of bituminous paint to concealed aluminum surfaces that will be in contact with cementitious or dissimilar materials.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.

- C. Install railings in compliance with ADA Standards for accessible design at applicable locations.
- D. Anchor railings securely to structure.
- E. Field weld anchors as indicated on drawings. Touch-up welds with primer. Grind welds smooth.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per floor level, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION 055213

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**SECTION 057000
DECORATIVE METAL**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Railing and guardrail assemblies.

1.02 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- D. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes 2017.
- E. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength 2021.
- F. ASTM A554 - Standard Specification for Welded Stainless Steel Mechanical Tubing 2021.
- G. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- H. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings 2009 (Reapproved 2015).
- I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength 2018a.
- J. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass 2019.
- K. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020.
- L. AWS D1.6/D1.6M - Structural Welding Code - Stainless Steel 2017.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Installation Meeting: Schedule and conduct a preinstallation meeting one week before starting work of this section. Attendees shall include, but not be limited to:
 - 1. Contractor.
 - 2. Manufacturer's representative.
 - 3. Architect.
 - 4. Owner's representative.
 - 5. Other subcontractors of adjacent work.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturer's product data including description of materials, components, finishes, fabrication details, glass, anchors, and accessories.
- C. Shop Drawings: Indicate railing system elevations and sections, details of profile, dimensions, sizes, connection attachments, anchorage, size and type of fasteners, and accessories. Indicate anchor and joint locations, brazed connections, transitions, and terminations.
- D. Samples: Submit one (1) of each item below for each type and condition shown.
 - 1. Glass: 12 inch by 12 inch, illustrating color, thickness and edge condition.
 - 2. Railing: 12 inch long section of handrail illustrating color, finish and connection detail.
 - 3. Cladding: 12 inch by 12 inch sample of each type of cladding, illustrating finish.
- E. Manufacturer's Installation Instructions.
- F. Maintenance Data: Manufacturer's instructions for care and cleaning.

- G. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Installation by manufacturer or an installer certified by the manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in factory provided protective coverings and packaging.
- B. Protect materials against damage during transit, delivery, storage, and installation at site.
- C. Inspect materials upon delivery for damage. Repair damage to be indistinguishable from undamaged areas; if damage cannot be repaired to be indistinguishable from undamaged parts and finishes, replace damaged items.
- D. Prior to installation, store materials and components under cover, in a dry location.

1.07 FIELD CONDITIONS

- A. Do not install railings until project is enclosed and ambient temperature of space is minimum 65 degrees F and maximum 95 degrees F.
- B. Maintain ambient temperature of space at minimum 65 degrees F and maximum 95 degrees F for 24 hours before, during, and after railing installation.

1.08 WARRANTY

- A. Warranty: Manufacturer's standard one year warranty against defects in materials, fabrication, finishes, and installation commencing on Date of Substantial Completion.

1.09 MANUFACTURERS

- A. Decorative Metal Railings:
 - 1. C. R. Laurence Co., Inc: www.crl-arch.com.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Railing Components:
 - 1. C. R. Laurence Co., Inc: www.crl-arch.com.

1.10 RAILING SYSTEMS

- 1. Design Criteria: Design and fabricate railings and anchorages to resist the following loads without failure, damage, or permanent set; loads do not need to be applied simultaneously.
 - a. Handrails: Comply with applicable accessibility requirements of ADA Standards.
- 2. Welded and Brazed Joints: Make exposed joints butt tight, flush, and hairline; use methods that avoid discoloration and damage of finish; grind smooth, polish, and restore to required finish.
 - a. Ease exposed edges to small uniform radius.
 - 1) Carbon Steel: Perform welding in accordance with AWS D1.1/D 1.1M.
 - 2) Stainless Steel: Perform welding in accordance with AWS D1.6/D1.6M.
- B. Structural Glass Railing System, Base-Mounted: Engineered, base supported railing system with structural glass.
 - 1. Top Rail: GRS 2 1/2" square premium cap
 - 2. Base Shoe, Aluminum (glass guardrail): ASTM B221 or ASTM B221M, 6063 alloy, T5 temper; 2-9/16" inch wide by 4-1/4" inch high, rectangular profile.
 - a. Type: CRL Fascia Mount Detail - Steel Substrate.
 - b. Cladding: Aluminum base shoes are to be clad in stainless steel with a No. 4 satin finish.
 - 3. Glass: As specified in this section.
 - 4. Stainless Steel Finish, Exposed Surfaces: No. 4 satin finish.
 - 5. Aluminum Finish, Exposed Surfaces: Matte Bronze.
 - 6. Fasteners:

- a. Attachment to Concrete:
 - 1) Provide anchors capable of sustaining, without failure, a load equal to four times the load imposed when installed in concrete, tested in accordance with ASTM E488/E448M.
- 7. Basis of Design: C.R. Laurence Co., Inc; "CRL GRS For Tempered Monolithic 1/2", 5/8" & 3/4" Thick Glass.

1.11 MATERIALS

- A. Aluminum Components: ASTM B221 or ASTM B221M. ASTM B209 or ASTM B209M.
 - 1. Matt Bronze.
- B. Stainless Steel Components:
 - 1. Stainless Steel Tubing: ASTM A554, Type 304, 16 gage, 0.0625 inch minimum metal thickness, 1-1/2 inch diameter.
 - 2. Stainless Steel Finish: No. 4 Bright Polished finish.
- C. Glass: Laminated safety glass; ASTM C1172, unless otherwise indicated.
 - 1. Plastic Interlayer: Minimum 0.060 inch thick.
 - 2. Thickness: 3/4 inch (thickness contingent on engineered product).
 - 3. Configuration: As indicated on drawings.
 - 4. Color (Guard Rail): Clear.

1.12 ACCESSORIES

- A. Anchors and Fasteners: Provide anchors and other materials as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.
 - 1. For anchorage to concrete, provide inserts to be cast into concrete for bolting anchors.
 - 2. For anchorage to masonry, provide brackets to be embedded in masonry for bolting anchors.
 - 3. For anchorage to stud walls, provide backing plates for bolting anchors.
 - 4. Exposed Fasteners: No exposed bolts or screws.
- B. Carbon Steel Bolts and Nuts: ASTM A307.

PART 3 EXECUTION

2.01 EXAMINATION

- A. Verify that substrate and site conditions are acceptable and ready to receive work.
- B. Verify field dimensions of locations and areas to receive work.
- C. Notify Architect immediately of conditions that would prevent satisfactory installation.
- D. Do not proceed with work until detrimental conditions have been corrected.
- E. Furnish components to be installed in other work to installer of that other work, including but not limited to blocking, sleeves, inserts, anchor bolts, embedded plates and supports for attachment of anchors.

2.02 PREPARATION

- A. Protect existing work.
- B. Review installation drawings before beginning installation. Coordinate diagrams, templates, instructions and directions for installation of anchorages and fasteners.
- C. Clean surfaces to receive units. Remove materials and substances detrimental to the installation.

2.03 INSTALLATION

- A. Comply with manufacturer's drawings and written instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects and with tight joints, except where necessary for expansion.
- C. Anchor securely to structure.

- D. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.
- E. Weld connections that cannot be shop welded due to size limitations.
 - 1. Weld in accordance with AWS D1.1/D1.1M.
 - 2. Match shop welding and bolting.
 - 3. Clean welds, bolted connections and abraded areas.
 - 4. Touch up shop primer and factory applied finishes.
 - 5. Repair galvanizing with galvanizing repair paint per ASTM A780/A780M.
- F. Isolate dissimilar materials with bituminous coating, bushings, grommets or washers to prevent electrolytic corrosion.

2.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per floor level, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

2.05 FIELD QUALITY CONTROL

- A. Field Services: Provide the services of the manufacturer for field observation of installation of railings.

2.06 CLEANING

- A. Remove protective film from exposed metal surfaces.
- B. Metal: Clean exposed metal finishes with potable water and mild detergent, in accordance with manufacturer recommendations; do not use abrasive materials or chemicals, detergents or other substances that may damage the material or finish.

2.07 PROTECTION

- A. Protect installed components and finishes from damage after installation.
- B. Repair damage to exposed finishes to be indistinguishable from undamaged areas.
 - 1. If damage to finishes and components cannot be repaired to be indistinguishable from undamaged finishes and components, replace damaged items.

**SECTION 061000
ROUGH CARPENTRY**

<<<<< UPDATE NOTES

PART 1 GENERAL

2.01 SECTION INCLUDES

- A. Non-structural dimension lumber framing.
- B. Concealed wood blocking, nailers, and supports.
- C. Miscellaneous wood nailers, furring, and grounds.

2.02 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- B. AWPA U1 - Use Category System: User Specification for Treated Wood 2018.
- C. PS 20 - American Softwood Lumber Standard 2020.
- D. SPIB (GR) - Grading Rules 2014.

2.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide technical data on insulated sheathing, wood preservative materials, and application instructions.
- C. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

2.04 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
- B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

PART 2 PRODUCTS

3.01 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. Species: Southern Pine, unless otherwise indicated.
 - 2. Grading Agency: Any grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
- B. Lumber fabricated from old growth timber is not permitted.

3.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Grading Agency: Southern Pine Inspection Bureau, Inc; SPIB (GR).
- B. Sizes: Nominal sizes as indicated on drawings, S4S.
- C. Moisture Content: S-dry or MC19.
- D. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S, No. 2 or Standard Grade.
 - 2. Boards: Standard or No. 3.

3.03 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.

2. Anchors: Toggle bolt type for anchorage to hollow masonry.

3.04 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 1. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

PART 3 EXECUTION

4.01 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

4.02 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- B. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- C. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
- D. Provide the following specific non-structural framing and blocking:
 1. Cabinets and shelf supports.
 2. Wall brackets.
 3. Grab bars.
 4. Chalkboards and marker board.
 5. Miscellaneous blocking.

4.03 TOLERANCES

- A. Framing Members: 1/4 inch from true position, maximum.
- B. Variation from Plane (Other than Floors): 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

4.04 CLEANING

- A. Waste Disposal: Comply with the requirements of Section 017419 - Construction Waste Management and Disposal.
 1. Comply with applicable regulations.
 2. Do not burn scrap on project site.
 3. Do not burn scraps that have been pressure treated.
 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- B. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.
- C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION 061000

SECTION 064100
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Specially fabricated cabinet units.
- B. Countertops.
- C. Hardware.

1.02 RELATED REQUIREMENTS

- A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 123600 - Countertops.

1.03 REFERENCE STANDARDS

- A. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards, U.S. Version 4.0 2021.
- B. BHMA A156.9 - American National Standard for Cabinet Hardware 2015.
- C. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood 2016.
- D. NEMA LD 3 - High-Pressure Decorative Laminates 2005.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting not less than one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Scale of Drawings: 1/4" to , minimum.
- C. Product Data: Provide data for hardware accessories.

1.06 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
 - 1. Company with at least one project in the past 5 years with value of woodwork within 20 percent of cost of woodwork for this Project.
 - 2. Single Source Responsibility: Provide and install this work from single fabricator.

1.07 MOCK-UPS

- A. Provide mock-up of typical base cabinet, wall cabinet, and countertop, including hardware, finishes, and plumbing accessories.
- B. Locate where directed.
- C. Mock-up may remain as part of the work.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from moisture damage.

1.09 FIELD CONDITIONS

- A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 CABINETS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS), unless noted otherwise.
- B. Cabinets:
 - 1. Finish - Exposed Interior Surfaces: Wood.
 - 2. Finish - Concealed Surfaces: Manufacturer's option.
 - 3. Door and Drawer Front Edge Profiles: Square edge with thin applied band.
 - 4. Casework Construction Type: Type A - Frameless.
 - 5. Interface Style for Cabinet and Door: Style 1 - Overlay; flush overlay.
 - 6. Grained Face Layout for Cabinet and Door Fronts: Flush panel.
 - a. Custom Grade: Doors, drawer fronts and false fronts wood grain to run and match vertically within each cabinet unit.
 - 7. Cabinet Design Series: As indicated on drawings.
 - 8. Cabinet Style: Flush overlay.
 - 9. Cabinet Doors and Drawer Fronts: Flush style.
 - 10. Drawer Construction Technique: As recommended by fabricator.

2.02 LAMINATE MATERIALS

- A. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.
- B. Provide specific types as indicated.
 - 1. Horizontal Surfaces: HGS, 0.048 inch nominal thickness, through color, [] color, finish as indicated.
 - 2. Vertical Surfaces: VGS, 0.028 inch nominal thickness, through color, [] color, finish as indicated.
 - 3. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

2.03 COUNTERTOPS

- A. Countertops: See Section 123600.

2.04 ACCESSORIES

- A. Adhesive: Type recommended by fabricator to suit application.
- B. Fasteners: Size and type to suit application.
- C. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.
- D. Concealed Joint Fasteners: Threaded steel.
- E. Grommets: Standard plastic, painted metal, or rubber grommets for cut-outs, in color to match adjacent surface.

2.05 HARDWARE

- A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.
- B. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards or multiple holes for pin supports and coordinated self rests, satin chrome finish, for nominal 1 inch spacing adjustments.
- C. Fixed Specialty Shelf Supports:
 - 1. Material: Steel.
 - 2. Product: L80-7 double slotted stanchion system or equal.
 - 3. Manufacturer: Southwest Solutions Group.
- D. Fixed Specialty Workstation and Countertop Brackets:
 - 1. Material: Steel.
 - 2. Finish: Manufacturer's standard, factory-applied powder coat.
 - 3. Color: Selected by Architect from manufacturer's standard range.

- 4. Manufacturers:
 - a. A&M Hardware, Inc ; Concealed Brackets: <http://www.aandmhardware.com/#sle>.
- E. Drawer and Door Pulls: Extruded aluminum pull, full width of drawer, satin finish.
 - 1. Finish: satin dark bronze.
- F. Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, bronze with satin finish.
- G. Cabinet Catches and Latches:
- H. Drawer Slides:
 - 1. Type: Full extension.
 - 2. Static Load Capacity: Commercial grade.
 - 3. Mounting: Side mounted.
 - 4. Stops: Integral type.
 - 5. Features: Provide self closing/stay closed type.
- I. Hinges: European style concealed self-closing type, steel with satin finish.

2.06 FABRICATION

- A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
- B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
- C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
- D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.
 - 1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
 - 2. Cap exposed plastic laminate finish edges with material of same finish and pattern.
- E. Mechanically fasten back splash to countertops as recommended by laminate manufacturer at 16 inches on center.
- F. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify location and sizes of utility rough-in associated with work of this section.

3.02 INSTALLATION

- A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.
- B. Use fixture attachments in concealed locations for wall mounted components.
- C. Use concealed joint fasteners to align and secure adjoining cabinet units.
- D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.
- E. Secure cabinets to floor using appropriate angles and anchorages.
- F. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.03 ADJUSTING

- A. Adjust installed work.
- B. Adjust moving or operating parts to function smoothly and correctly.

3.04 CLEANING

- A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION 064100

**SECTION 070553
FIRE AND SMOKE ASSEMBLY IDENTIFICATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Identification markings for fire and smoke rated partitions, and fire rated walls.

1.02 RELATED REQUIREMENTS

- A. Section 099123 - Interior Painting: Paint finish.

1.03 REFERENCE STANDARDS

- A. Florida Building Code, Building (FBC-B), 5th Edition.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's printed product literature for each type of marking, indicating font, foreground and background colors, wording, and overall dimensions.
- C. Schedule: Completely define scope of proposed marking. Indicate location of affected walls and partitions, and number of markings.

1.05 FIELD CONDITIONS

- A. Do not install painted markings when ambient temperature is lower than recommended by coating manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Partition Identification Labels:
 - 1. Fire Wall Signs, Inc: www.firewallsigns.com.
 - 2. Safety Supply Warehouse, Inc: www.safetysupplywarehouse.com.

2.02 FIRE AND SMOKE ASSEMBLY IDENTIFICATION

- A. Regulatory Requirements: Comply with "Markings and Identification" requirements of "Fire-Resistance Ratings for Fire Tests" chapter of the Florida Building Code (FBC-B).
- B. Adhered Fire and Smoke Assembly Identification Signs: Printed vinyl sign with factory applied adhesive backing.
- C. Languages: Provide all markings in English.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION

- A. Install adhered markings in accordance with manufacturer's instructions.
- B. Install markings as required by Florida Building Code (FBC-B)
- C. Install neatly, with horizontal edges level.
- D. Protect from damage until Substantial Completion; repair or replace damaged markings.

END OF SECTION 070553

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SECTION 072100 THERMAL INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Board insulation at exterior wall behind [] wall finish.
- B. Batt insulation in exterior wall construction.
- C. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.

1.02 RELATED REQUIREMENTS

- A. Section 072700 - Air Barriers: Separate air barrier materials.

1.03 REFERENCE STANDARDS

- A. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).
- B. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing 2017.
- C. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board 2021.
- D. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings 2019.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- F. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C 2019a.
- G. ASTM E1414/E1414M - Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum 2021a.
- H. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components 2019.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.05 FIELD CONDITIONS

- A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A. Insulation Over Metal Stud Framed Walls, Continuous: Polyisocyanurate board.
- B. Insulation in Metal Framed Walls: Batt insulation with separate vapor retarder.
- C. Insulation Above Lay-In Acoustical Ceilings: Batt insulation with no vapor retarder.

2.02 FOAM BOARD INSULATION MATERIALS

- A. Polyisocyanurate (ISO) Board Insulation: Rigid cellular foam, complying with ASTM C1289.
 - 1. Classifications:
 - a. Type II: Faced with either organic felt facers or glass fiber mat facers on both major surfaces of the core foam.

- 1) Class 1 - Faced with glass fiber reinforced cellulosic felt facers on both major surfaces of core foam.
- 2) Compressive Strength: Classes 1-2-3, Grade 1 - 16 psi (110 kPa), minimum.
- 3) Thermal Resistance, R-value: At 1-1/2 inch thick; Class 1, Grades 1-2-3 - 8.4 (1.48), minimum, at 75 degrees F.
- b. Type V: Faced with oriented strand board (OSB) or plywood on one major surface of core foam and glass fiber reinforced cellulosic felt or uncoated or coated polymer-bonded glass fiber mat facer on other major surface of core foam.
 - 1) Compressive Strength: 16 psi, minimum.
 - 2) Thermal Resistance, R-value: At 1-1/2 inch thick; 6.2, minimum, at 75 degrees F.
2. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
3. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
4. Complies with fire resistance requirements indicated on drawings as part of an exterior non-load-bearing exterior wall assembly when tested in accordance with NFPA 285.
5. Board Size: 48 inch by 96 inch.
6. Board Thickness: 1.75 inch.
7. Products:
 - a. Atlas Roofing Corporation; EnergyShield CGF PRO: www.atlasroofing.com/#sle.

2.03 BATT INSULATION MATERIALS

- A. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
 1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
 2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
 3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
 4. Facing: Unfaced.
 5. Products:
 - a. CertainTeed Corporation; Insulpure: www.certainteed.com/#sle.
 - b. Johns Manville; Cavity-Shield: www.jm.com/#sle.
 - c. Owens Corning Corporation; EcoTouch PINK FIBERGLAS Insulation: www.ocbuildingspec.com/#sle.

2.04 ACCESSORIES

- A. Tape: Reinforced polyethylene film with acrylic pressure sensitive adhesive.
 1. Application: Sealing of interior circular penetrations, such as pipes or cables.
 2. Width: Are required for application.
- B. Insulation Fasteners: Lengths of unfinished, 13 gauge, 0.072 inch high carbon spring steel with chisel or mitered tips, held in place by tension, length to suit insulation thickness and substrate, capable of securely supporting insulation in place.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
- B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 BOARD INSTALLATION AT EXTERIOR WALLS

- A. Adhere 6 inches wide strip of polyethylene sheet over expansion joints with double beads of adhesive each side of joint.
 1. Tape seal joints between sheets.
- B. Install boards horizontally on walls.
- C. Extend boards over expansion joints, unbonded to wall on one side of joint.

- D. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BATT INSTALLATION

- A. Install insulation and vapor retarder in accordance with manufacturer's instructions.
- B. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
- E. At metal framing, place vapor retarder on warm side of insulation; lap and seal sheet retarder joints over face of member
- F. Tape seal tears or cuts in vapor retarder.
- G. Extend vapor retarder tightly to full perimeter of adjacent window and door frames and other items interrupting the plane of the membrane; tape seal in place.

3.04 PROTECTION

- A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION 072100

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**SECTION 072500
WEATHER BARRIERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fluid applied vapor-permeable, membrane air and water barrier.

1.02 RELATED REQUIREMENTS

- A. Section 092116 - Gypsum Board Assemblies: Water-resistive barrier under exterior cladding.

1.03 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency current edition.
- B. AATCC Test Method 127 - Test Method for Water Resistance: Hydrostatic Pressure 2018, with Editorial Revision (2019).
- C. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection 2020.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- E. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials 2016.
- F. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials 2021a.
- G. ICC-ES AC38 - Acceptance Criteria for Water-Resistive Barriers 2016, with Editorial Revision (2019).
- H. ICC-ES AC148 - Acceptance Criteria for Flexible Flashing Materials 2017.
- I. ICC-ES AC212 - Acceptance Criteria for Water-Resistive Coatings Used as Water-Resistive Barriers over Exterior Sheathing 2015.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on material characteristics.
- C. Manufacturer's Installation Instructions: Indicate preparation.

1.05 QUALITY ASSURANCE

- A. Materials shall be manufactured at a facility covered by a current ISO 9001:2015 and ISO 14001:2015 certification. Certification of the facility shall be done by a registrar accredited by the American National Standards Institute, Registrar Accreditation Board (ANSI-RAB).
- B. Contractor: Shall be experienced and competent in the waterproofing trade and application of liquid air and water-resistive barriers.

1.06 MOCK-UP

- A. Install air and water resistive barrier materials in mock-up at a location indicated by the architect.

1.07 FIELD CONDITIONS

- A. Maintain temperature and humidity recommended by the materials manufacturers before, during and after installation.

PART 2 PRODUCTS

2.01 WEATHER BARRIER ASSEMBLIES

- A. Air and Water-Resistive Barrier: Provide on exterior walls under exterior cladding.

2.02 AIR BARRIER MATERIALS (WATER VAPOR PERMEABLE AND WATER-RESISTIVE)

- A. Air and Water Barrier, Fluid Applied: Vapor permeable, polymer based air / water resistive barrier.
 - 1. Air Barrier Coating:
 - a. Material: Flexible, polymer based, non-cementitious.
 - b. Acceptable Substrates: Stated by manufacturer as suitable for installation on visibly damp surfaces and concrete that has hardened but is not fully cured ("green" concrete) without requiring a primer.
 - c. Adhesion to Paper and Glass Mat Faced Sheathing: Sufficient to ensure failure due to delamination of sheathing.
 - d. Dry Film Thickness (DFT): 10 mil, 0.010 inch, minimum.
 - e. Air Permeance: 0.0001 cubic feet per minute per square foot, maximum, when tested in accordance with ASTM E2178.
 - f. Water Vapor Permeance: 7 perms, minimum, when tested in accordance with ASTM E96/E96M, Procedure B.
 - g. Ultraviolet (UV) and Weathering Resistance: Approved in writing by manufacturer for up to six months of weather exposure after application.
 - h. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - i. Code Acceptance: Comply with applicable requirements of ICC-ES AC212.
 - j. Sealants, Tapes and Accessories: As recommended by coating manufacturer.
 - k. Manufacturers:
 - 1) (Basis of Design) Dryvit Systems, Backstop NT..
 - 2) Substitutions: See Section 016000 - Product Requirements.

2.03 ACCESSORIES

- A. Sealants, Tapes, and Accessories for Sealing Weather Barrier to Adjacent Substrates: As specified or as recommended by weather barrier manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and conditions are ready to accept the work of this section.

3.02 PREPARATION

- A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.
- B. Clean and prime substrate surfaces to receive adhesives in accordance with manufacturer's instructions.

3.03 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Coatings:
 - 1. Prepare substrate in manner recommended by coating manufacturer; treat joints in substrate and between dissimilar materials as recommended by manufacturer.
 - 2. Where exterior masonry veneer is to be installed, install masonry anchors before installing weather barrier over masonry; seal around anchors air tight.
 - 3. Use flashing to seal to adjacent construction and to bridge joints.
- C. Openings and Penetrations in Exterior Weather Barriers:
 - 1. Install flashing over sills, covering entire sill frame member, extending at least 5 inches onto weather barrier and at least 6 inches up jambs; mechanically fasten stretched edges.
 - 2. At openings to be filled with frames having nailing flanges, seal head and jamb flanges using a continuous bead of sealant compressed by flange and cover flanges with sealing tape at least 4 inches wide; do not seal sill flange.
 - 3. At openings to be filled with non-flanged frames, seal weather barrier to each side of opening framing, using flashing at least 9 inches wide, covering entire depth of framing.

4. At head of openings, install flashing under weather barrier extending at least 2 inches beyond face of jambs; seal weather barrier to flashing.
5. At interior face of openings, seal gap between window/door frame and rough framing, using joint sealant over backer rod.
6. Service and Other Penetrations: Form flashing around penetrating item and seal to weather barrier surface.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Coordination of ABAA Tests and Inspections:
 1. Provide testing and inspection required by ABAA QAP.
 2. Notify ABAA in writing of schedule for air barrier work, and allow adequate time for testing and inspection.
 3. Cooperate with ABAA testing agency.
 4. Allow access to air barrier work areas and staging.
 5. Do not cover air barrier work until tested, inspected, and accepted.
- C. Obtain approval of installation procedures by the weather barrier manufacturer based on a mock-up installed in place, prior to proceeding with remainder of installation.
- D. Take digital photographs of each portion of the installation prior to covering up.

3.05 PROTECTION

- A. Do not leave materials exposed to weather longer than recommended by manufacturer.

END OF SECTION 072500

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**SECTION 074213
METAL WALL PANELS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Horizontal Ribbed Wall Panels.
- B. Flat Lock Tile Metal Wall Panels.

1.02 RELATED REQUIREMENTS

- A. Section 072100 - Thermal Insulation.
- B. Section 072500 - Weather Barriers: Water-resistive barrier under wall panels.
- C. Section 072700 - Air Barriers: Air barrier under wall panels.
- D. Section 079200 - Joint Sealants: Sealing joints between metal wall panel system and adjacent construction.

1.03 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2021.

1.04 SUBMITTALS

- A. Shop Drawings: Indicate dimensions, layout, joints, construction details, methods of anchorage.
- B. Samples: Submit two samples of wall panel and soffit panel, 4 inch by 4 inch in size illustrating finish color, sheen, and texture.
- C. Installer's qualification statement.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years of documented experience.
- B. Installer Qualifications: Company specializing in installing products of the type specified in this section with minimum three years of documented experience.

1.06 MOCK-UPS

- A. Construct mock-up, 6 feet long by 4 feet wide; include panel system, glazing, attachments to building frame, associated vapor retarder and air seal materials, weep drainage system, sealants and seals, related insulation in mock-up.
- B. Mock-up may remain as part of work.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
- B. Store prefinished material off the ground and protected from weather; prevent twisting, bending, or abrasion; provide ventilation; slope metal sheets to ensure proper drainage.
- C. Prevent contact with materials that may cause discoloration or staining of products.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Correct defective work within a five year period after Date of Substantial Completion for degradation of panel finish, including color fading caused by exposure to weather.
- C. Correct defective work within a five year period after Date of Substantial Completion, including defects in water tightness and integrity of seals for metal wall panels.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design: Metal Wall Panels - Exposed Fasteners:
 - 1. ATAS International, Inc; Belvedere 7.2 Inch Rib: www.atas.com/#sle.
- B. Basis of Design: Concealed Fastener - Flat Lock Panel:
 - 1. Atas International, Inc; Versa-Lok: www.atas.com/#sle.

2.02 METAL WALL PANEL MATERIALS

- A. Wall Panel System: Factory fabricated prefinished metal panel system, site assembled.
 - 1. Provide exterior panels.
 - 2. Design and size components to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of wall.
 - 3. Maximum Allowable Deflection of Panel: L/180 for length(L) of span.
 - 4. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
 - 5. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
 - 6. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
 - 7. Provide continuity of air barrier seal at building enclosure elements; see Section 072700.
- B. Exterior Wall Panels:
 - 1. Profile: Horizontal; BWR360.
 - 2. Side Seams: Double-interlocked, tight-fitting, sealed with continuous gaskets.
 - 3. Material: Precoated aluminum sheet, 20 gauge, 0.032 inch minimum thickness.
 - 4. Panel Width: 36 inches.
 - 5. Panel Depth: 1 1/2 inch
 - 6. Flame Spread Testing: ASTM E84
 - 7. Color: As selected by Architect from manufacturer's standard line.
 - 8. Texture: Smooth and Perforated (see drawings for locations)
- C. Flat Lock Tiles:
 - 1. Tile Shape: Rectangular; [VSL 123]
 - 2. Size: 12" x 36"
 - 3. Orientation: Horizontal
 - 4. Material: 20 gage, 0.032 inch aluminum
 - 5. Flame Spread Testing: ASTM E84
 - 6. Color: As selected by Architect from manufacturer's standard line.
 - 7. Texture: Smooth
- D. Internal and External Corners: Same material, thickness, and finish as exterior sheets; profile to suit system; shop cut and factory mitered to required angles.
- E. Trim: Same material, thickness and finish as exterior sheets; brake formed to required profiles.
 - 1. Provide elite trim profiles for Horizontal Exterior Wall Panels as follows:
 - a. Endwall Channel
 - b. Reveal Extrusion
 - c. Base Extrusion
 - d. Head Extrusion
 - e. Jamb Extrusion
- F. Anchors: Aluminum or Stainless steel.

2.03 MATERIALS

- A. Precoated Aluminum Sheet: ASTM B209/B209M, 3105 alloy, O temper, smooth surface texture; continuous-coil-coated on exposed surfaces with specified finish coating and on panel back with specified panel back coating.

2.04 FINISHES

- A. Exposed Surface Finish: Panel manufacturer's standard polyvinylidene fluoride (PVDF) coating, top coat over epoxy primer.
- B. Panel Backside Finish: Panel manufacturer's standard siliconized polyester wash coat.

2.05 ACCESSORIES

- A. Concealed Sealants: Non-curing butyl sealant or tape sealant.
- B. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.
- C. Fasteners: Manufacturer's standard type to suit application; with soft neoprene washers, steel, hot dip galvanized. Fastener cap same color as exterior panel.
- D. Field Touch-up Paint: As recommended by panel manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that building framing members are ready to receive panels.
- B. Verify that air barrier has been installed over substrate completely and correctly; see Section 072700.

3.02 INSTALLATION

- A. Install panels on walls and soffits in accordance with manufacturer's instructions.
- B. Protect surfaces in contact with cementitious materials and dissimilar metals with bituminous paint. Allow to dry prior to installation.
- C. Fasten panels to structural supports; aligned, level, and plumb.
- D. Locate joints over supports.
- E. Provide expansion joints where indicated.
- F. Use concealed fasteners unless otherwise approved by Architect.
- G. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.

3.03 TOLERANCES

- A. Maximum Offset From True Alignment Between Adjacent Members Butting or In Line: 1/16 inch.
- B. Maximum Variation from Plane or Location Indicated on Drawings: 1/4 inch.

3.04 CLEANING

- A. Remove site cuttings from finish surfaces.
- B. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.

END OF SECTION 074213

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- F. Anchors: Aluminum or Stainless steel.

2.03 MATERIALS

- A. Precoated Aluminum Sheet: ASTM B209 (ASTM B209M), 3105 alloy, O temper, smooth surface texture; continuous-coil-coated on exposed surfaces with specified finish coating and on panel back with specified panel back coating.

2.04 FINISHES

- A. Exposed Surface Finish: Panel manufacturer's standard polyvinylidene fluoride (PVDF) coating, top coat over epoxy primer.
- B. Panel Backside Finish: Panel manufacturer's standard siliconized polyester wash coat.

2.05 ACCESSORIES

- A. Concealed Sealants: Non-curing butyl sealant or tape sealant.
- B. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.
- C. Fasteners: Manufacturer's standard type to suit application; with soft neoprene washers, [_____] [_____]
- D. Field Touch-up Paint: As recommended by panel manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that building framing members are ready to receive panels.
- B. Verify that weather barrier has been installed over substrate completely and correctly.

3.02 INSTALLATION

- A. Install panels on walls and soffits in accordance with manufacturer's instructions.
- B. Protect surfaces in contact with cementitious materials and dissimilar metals with bituminous paint. Allow to dry prior to installation.
- C. Fasten panels to structural supports; aligned, level, and plumb.
- D. Locate joints over supports.
- E. Provide expansion joints where indicated.
- F. Use concealed fasteners unless otherwise approved by Architect.
- G. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.

3.03 TOLERANCES

- A. Maximum Offset From True Alignment Between Adjacent Members Butting or In Line: 1/16 inch.
- B. Maximum Variation from Plane or Location Indicated on Drawings: 1/4 inch.

3.04 CLEANING

- A. Remove site cuttings from finish surfaces.
- B. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.

END OF SECTION 074213

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**SECTION 074243
COMPOSITE WALL PANELS**

Part I - General

1.1 SECTION INCLUDES:

- A. Exterior, panelized fiber cement cladding system and accessories to complete a drained and back-ventilated rainscreen.
- B. Interior fiber cement panelized cladding system and accessories.

1.2 RELATED SECTIONS

- A. Section 05 41 00 - Structural Metal Stud Framing
- B. Section 06 10 00 - Rough Carpentry
- C. Section 06 16 00 - Sheathing
- D. Section 07 20 00 - Thermal Protection
- E. Section 07 25 00 - Weather Barriers
- F. Section 07 60 00 - Flashing and Sheet Metal
- G. Section 07 90 00 - Joint Protection

1.3 REFERENCES

- A. American Architectural Manufacturers Association (AAMA):
 - 1. AAMA 509-14 – Voluntary Test and Classification Method of Drained and Back Ventilated Rain Screen Wall Cladding Systems
- B. ASTM International (ASTM):
 - 1. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - 2. ASTM C 1185 - Standard Test Methods for Sampling and Testing Non-Asbestos Fiber Cement.
 - a. ASTM C 1186 – Standard Specification for Flat Fiber-Cement Sheets.
 - 3. ASTM E-84 - Standard Test for Surface Burning Characteristics of Building Materials.
 - 4. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 5. ASTM E 228 - Standard Test Method for Linear Thermal Expansion of Solid Materials with a Vitreous Silica Dilatometer.
 - 6. ASTM E 330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
 - 7. ASTM E 331 - Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
- C. Florida Building Code - Test Protocol HVHZ
 - 1. Testing Application Standard (TAS) 202, 203 – HVHZ Test Procedures
- D. National Fire Protection Association (NFPA):

1. NFPA 285 - Fire Test Method for Exterior Wall Assemblies Containing Combustible Material.
 2. NFPA 268 – Ignition Resistance of Exterior Wall Assemblies.
- E. Standards Council of Canada & Underwriters Laboratories Canada (ULC):
1. CAN/ULC S-102 – Standard Method of Test for Surface Burning Characteristics.
 2. CAN/ULC S-134 – Standard Method of Fire Test of Exterior Wall Assembly.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. Product Data: Submit manufacturer's product description, storage and handling requirements, and installation instructions.
- C. Product Test Reports and Code Compliance: Documents demonstrating product compliance with local building code, such as test reports or Evaluation Reports from qualified, independent testing agencies.
- D. LEED Credits: Provide documentation of LEED Credits for project certification under USGBC LEED 2009 (Version 3.0) or 2012 v.4.
- E. Manufacturer's Details: Submit drawings (.dwg, .rvt, and/or .pdf formats), including plans, sections, showing installation details that demonstrate product dimensions, edge/termination conditions/treatments, compression and control joints, corners, openings, and penetrations.
- F. Samples: Submit samples of each product type proposed for use.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
1. All fiber cement panels specified in this section must be supplied by a manufacturer with a minimum of 10 years of experience in fabricating and supplying fiber cement cladding systems.
 - a. Products covered under this section are to be manufactured in an ISO 9001 certified facility.
 2. Provide technical and design support as needed regarding installation requirements and warranty compliance provisions.
- B. Installer Qualifications: All products listed in this section are to be installed by a single installer trained by manufacturer or representative.
- C. Mock-Up Wall: Provide a mock-up wall as evaluation tool for product and installation workmanship.
- D. Pre-Installation Meetings: Prior to beginning installation, conduct conference to verify and discuss substrate conditions, manufacturer's installation instructions and warranty requirements, and project requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Panels must be stored flat and kept dry before installation. A waterproof cover over panels and accessories should be used at all times prior to installation. Do not stack pallets more than two high. Refer to the information included on each pallet.

B. If panels are exposed to water or water vapor prior to installation, allow to completely dry before installing. Failure to do so may result in panel shrinkage at ship lap joints, and such action may void warranty.

C. Panels MUST be carried on edge. Do not carry or lift panels flat. Improper handling may cause cracking or panel damage.

D. Direct contact between the panels and the ground should be avoided at all times. It is necessary to keep panels clean during installation process.

1.7 WARRANTY

A. Provide manufacturer's 15-year warranty against manufactured defects in fiber cement panels. Additional 5-year extension available when refinished in year 14-15.

B. Provide manufacturer's 15-year warranty against manufactured defects in panel finish.

C. Warranty provides for the original purchaser. See warranty for detailed information on terms, conditions and limitations.

PART II: PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Nichiha Corporation, 18-19 Nishiki 2-chome Naka-ku, Nagoya, Aichi 460-8610, Japan.

B. Acceptable Manufacturer's Representative: Nichiha USA, Inc., 6465 E. Johns Crossing, Suite 250, Johns Creek, GA 30097. Toll free: 1.866.424.4421, Office: 770.805.9466, Fax: 770.805.9467, www.nichiha.com.

1. Basis of Design Product: Nichiha VintageWood.

a. Profile colors: Bark, Cedar, Redwood, Ash, and Spruce.

b. Profiles: Wood plank texture with three, 3/8" grooves running lengthwise, spaced 5-5/8" apart.

c. Accessory/Component Options:

i. Manufactured Corners with 3-1/2" returns for each profile color.

ii. Aluminum trim options: Corner Key, Open Outside Corner, H-Mold, J-Mold, Compression Joint, Inside Corner

1. Finish: Bark, Cedar, Clear Anodized, or Primed.

iii. Essential Flashing System: Starter, Overhang.

1. Finish: Matte black.

d. Dimensions:

1. AWP-1818: 455mm (17-7/8") (h) x 1,818 mm (71-9/16") (l).

2. AWP-3030: 455mm (17-7/8") (h) x 3,030 mm (119-5/16") (l).

e. Panel Thickness: 16 mm (5/8").

f. Weight: AWP-1818: 35.27 lbs. per panel, AWP-3030: 57.32 lbs. per panel.

g. Coverage: 8.88 sq. ft. per panel (1818), 14.81 sq. ft. per panel (3030).

h. Factory sealed on six [6] sides.

C. Substitutions: Not permitted.

D. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00.

2.2 MATERIALS

A. Fiber cement panels manufactured from a pressed, stamped, and autoclaved mix of Portland cement, fly ash, silica, recycled rejects, and wood fiber bundles.

B. Panel surface pre-finished and machine applied.

C. Panels profiled along 3030mm edges so that the long joints between the installed panels are ship-lapped.

D. Factory-applied sealant gasket added to top panel edge; all 3030mm edge joints contain a factory sealant.

2.3 PERFORMANCE REQUIREMENTS:

A. Fiber Cement Cladding – Must comply with ASTM C-1186, Type A, Grade II requirements:

1. Wet Flexural Strength: Result: 1418 psi, Lower Limit: 1015 psi.

2. Water Tightness: No water droplets observed on any specimen.

3. Freeze-thaw: No damage or defects observed.

4. Warm Water: No evidence of cracking, delamination, swelling, or other defects observed.

5. Heat-Rain: No crazing, cracking, or other deleterious effects, surface or joint changes observed in any specimen.

B. Mean Coefficient of Linear Thermal Expansion (ASTM E-228): Max 1.0×10^{-5} in./in. F.

C. Surface Burning (CAN-ULC S102/ASTM E-84): Flame Spread: 0, Smoke Developed: 0.

D. Wind Load (ASTM E-330): Contact manufacturer for ultimate test pressure data corresponding to framing type, dimensions, fastener type, and attachment clips. Project engineer(s) must determine Zone 4 and 5 design pressures based on project specifics.

1. Minimum lateral deflection: L/120.

E. Water Penetration (ASTM E-331): No water leakage observed into wall cavity.

F. Steady-State Heat Flux and Thermal Transmission Properties Test (ASTM C-518): 16mm thick panel thermal resistance R Value of 0.47.

G. Fire Resistant (ASTM E-119): The wall assembly must successfully endure 60-minute fire exposure without developing excessive unexposed surface temperature or allowing flaming on the unexposed side of the assembly.

H. Ignition Resistance (NFPA 268): No sustained flaming of panels, assembly when subjected to a minimum radiant heat flux of 12.5 kW/m² ± 5% in the presence of a pilot ignition source for a 20-minute period.

I. Fire Propagation (NFPA 285): Wall assembly of Nichiha AWP, Ultimate Clips and Starter Track, Tyvek Commercial Wrap, ½" Densglass Gold Sheathing, 16" o.c. 18 gauge steel studs, mineral wool in-cavity insulation, and interior 5/8" Type X gypsum met the acceptance criteria of NFPA 285.

J. Fire Propagation (CAN/ULC S-134): Wall assembly of Nichiha AWP, Ultimate Clips and Starter Track, Tyvek Housewrap, 5/8" FRT plywood, 16" o.c. 2x wood studs, fiberglass in-cavity insulation, and interior 5/8" Type X gypsum met the acceptance criteria of CAN/ULC S-134.

K. Drained and Back Ventilated Rainscreen (AAMA 509-14): System classifications: W1, V1.

L. Florida Building Code - Test Protocol HVHZ (TAS 202, 203): Horizontal Application Design Pressure: 95 psf, Vertical Application Design Pressure: 85 psf.

2.4 INSTALLATION COMPONENTS

A. Ultimate Clip System:

1. Starter Track:

- a. Horizontal Panel Installations - FA 700 – 3,030mm (I) galvalume coated steel.
- b. Vertical Panel Installations (AWP-3030 only) – FA 710T – 3,030mm (I) galvalume coated steel.

2. Panel Clips: JEL 778 "Ultimate Clip II" (10mm rainscreen for 16mm AWP) – Zinc-Aluminum-Magnesium alloy coated steel.

- a. Joint Tab Attachments (included) – used at all AWP-1818 panel to panel vertical joints, NOT used with AWP-3030 installations.

3. Corner Clips: JE 777C (10mm rainscreen for 5/8" AWP Manufactured Corners) -- Zinc-Aluminum-Magnesium alloy coated steel.

4. Single Flange Sealant Backer – FHK 1015 R (10mm) – 6.5' (I) fluorine coated galvalume.
5. Double Flange Sealant Backer – FH 1015 R (10mm) – 10' (I) fluorine coated galvalume.
6. Corrugated Spacer – FS 1005 (5mm), FS 1010 (10mm) – 4' (I).

B. Aluminum Trim (optional): Paint primed trim as specified in finish schedule.

C. Essential Flashing System (optional):

1. Starter – main segments (3,030mm), inside corners, outside corners
2. Overhang – main segments (3,030mm), inside corners, outside corners, joint clips

D. Fasteners: Corrosion resistant fasteners, such as hot-dipped galvanized screws appropriate to local building codes and practices must be used. Use Stainless Steel fasteners in high humidity and high-moisture regions. Panel manufacturer is not liable for corrosion resistance of fasteners. Do not use aluminum fasteners, staples or fasteners that are not rated or designed for intended use. See manufacturer's instructions for appropriate fasteners for construction method used.

- E. Flashing: Flash all areas specified in manufacturer's instructions. Do not use raw aluminum flashing. Flashing must be galvanized, anodized, or PVC coated.
- F. Sealant: Sealant shall comply with ASTM C920, Class 35.

PART III: EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Fiber cement panels can be installed over braced wood, steel studs and sheathing including plywood, OSB, plastic foam (1" or less) or fiberboard sheathing. Fiber cement panels can also be installed over Structural Insulated Panels (SIP's), Concrete Masonry Units (CMU's) and Concrete Block Structures (CBS's) with furring strips, and Pre-Engineered Metal Construction. Insulated Concrete Forms (ICFs) require added measures. Consult with Nichiha Technical Services.
2. Allowable stud spacing: 16" o.c. maximum.
3. A weather resistive barrier is required when installing fiber cement panels. Use an approved weather resistive barrier (WRB) as defined by the 2015 IBC or IRC. Refer to local building codes.
4. Appropriate metal flashing should be used to prevent moisture penetration around all doors, windows, wall bottoms, material transitions and penetrations. Refer to local building codes for best practices.

B. Examine site to ensure substrate conditions are within alignment tolerances for proper installation.

C. Do not begin installation until unacceptable conditions have been corrected.

D. Do not install panels or components that appear to be damaged or defective. Do not install wet panels.

3.2 TOLERANCE

A. Wall surface plane must be plumb and level within +/- ¼ inch in 20 feet in any direction.

1. One layer of Nichiha 5mm (~3/16") Spacer may be used as shim.

3.3 INSTALLATION

A. General: Install products in accordance with the latest installation guidelines of the manufacturer and all applicable building codes and other laws, rules, regulations and ordinances. Review all manufacturer installation, maintenance instructions, and other applicable documents before installation.

1. Consult with your local dealer or Nichiha Technical Department before installing any Nichiha fiber cement product on a building higher than 45 feet or three stories or for conditions not matching prescribed standard installation guide requirements and methods. A **Technical Design Review (TDR)** process is available to evaluate project feasibility.

2. **Vertical Control/Expansion Joints** are required with AWP-1818, for walls wider than 30 feet, within 2-12 feet of outside corners finished with metal trim *and* approximately every 30 feet thereafter.

A. **Vertical Control/Expansion Joints** are required at each AWP-3030 vertical joint, or H-Mold trim may be used instead.

3. **Horizontal/Compression Joints** are required for multi-story installations of AWP. Locate joints at floor lines. Joints are flashed minimum ½" breaks. Do not caulk. Refer to installation guide(s).

A. Wood framed buildings of three or more floors require a compression joint at each floor.

B. Steel framed buildings (including reinforced concrete core with LGMF exterior walls) of more than three floors (or 45 feet) require a compression joint every 25 feet at a floor line.

B. Panel Cutting

1. Always cut fiber cement panels outside or in a well ventilated area. Do not cut the products in an enclosed area.

2. Always wear safety glasses and NIOSH/OSHA approved respirator whenever cutting, drilling, sawing, sanding or abrading the products. Refer to manufacturer SDS for more information.

3. Use a dust-reducing circular saw with a diamond-tipped or carbide-tipped blade.

a. Recommended circular saw: Makita 7-1/4" Circular Saw with Dust Collector (#5057KB).

b. Recommended blade: Tenryu Board-Pro Plus PCD Blade (#BP-18505).

c. Shears (electric or pneumatic) or jig saw can be used for complicated cuttings, such as service openings, curves, radii and scrollwork.

4. **Silica Dust Warning:** Fiber cement products may contain some amounts of crystalline silica, a naturally occurring, potentially hazardous mineral when airborne in dust form. Consult product SDS or visit <https://www.osha.gov/dsg/topics/silicacrystalline/>.

5. Immediately clean dust from cut panels as it may bind to the finish.

3.4 CLEANING AND MAINTENANCE

A. Review manufacturer guidelines for detailed care instructions.

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**SECTION 075419
POLYVINYL-CHLORIDE ROOFING**

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Preparation of Substrate to Receive Roofing Materials
- B. Base Sheet or Roof Insulation Application to Prepared Substrate
- C. Roof Membrane Application
- D. Roof Flashing Application
- E. Incorporation of Sheet Metal Flashing Components and Roofing Accessories into the Roof System

1.02 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Sheet Metal Flashing and Trim
- B. Sheet Metal Roofing Specialties

1.03 RELATED SECTIONS

- A. Section [----] - Rough Carpentry
- B. Section [----] - Roof Decks
- C. Section [----] - Sheet Metal Flashing and Trim
- D. Section [----] - Sheet Metal Roofing Specialties

1.04 REFERENCE STANDARDS

REFERENCES IN THESE SPECIFICATIONS TO STANDARDS, TEST METHODS AND CODES, ARE IMPLIED TO MEAN THE LATEST EDITION OF EACH SUCH STANDARD ADOPTED. THE FOLLOWING IS AN ABBREVIATED LIST OF ASSOCIATIONS, INSTITUTIONS, AND SOCIETIES WHICH MAY BE USED AS REFERENCES THROUGHOUT THIS SPECIFICATION SECTION.

ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS PHILADELPHIA, PA
FM	FACTORY MUTUAL ENGINEERING AND RESEARCH NORWOOD, MA
NRCA	NATIONAL ROOFING CONTRACTORS ASSOCIATION ROSEMONT, IL
OSHA	OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION WASHINGTON, DC
SMACNA	SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION CHANTILLY, VA
UL	UNDERWRITERS LABORATORIES NORTHBROOK, IL

1.05 DESCRIPTION OF WORK

THE BASIC WORK DESCRIPTIONS REQUIRED IN THIS SPECIFICATION ARE REFERENCED BELOW.

**PROJECT TYPE: NEW CONSTRUCTION
DECK: SLOPED METAL
MIN. SLOPE: ¼**

INSULATION (bottom layer): Paratherm rigid insulation providing for an R-value that is called out on the drawings, mechanically fastened with the top layer of insulation.

INSULATION (top layer): DensDeck Prime, having a thickness of ½ inch, mechanically fastened to approved fastening pattern.

**ROOF SYSTEM: PARADIENE 20 TG, TORCH APPLIED
80 MIL PARASOLO KEE FLEECEBACK ROOF MEMBRANE, APPLIED
IN PARAFAST T LOW RISE ADHESIVE.**

FLASHING SYSTEM: 80 mil Parasolo KEE detailing membrane applied in bonding adhesive.

SUPPLEMENTAL FLASHING: Parapro 123 Flashing System

1.06 SUBMITTALS

ALL SUBMITTALS WHICH DO NOT CONFORM TO THE FOLLOWING REQUIREMENTS WILL BE REJECTED.

A. SUBMITTAL OF EQUALS: SUBMIT PRIMARY ROOF SYSTEMS TO BE CONSIDERED AS EQUALS TO THE SPECIFIED ROOF SYSTEM NO LESS THAN 10 DAYS PRIOR TO BID DATE. PRIMARY ROOF SYSTEMS WHICH HAVE BEEN REVIEWED AND ACCEPTED AS EQUALS TO THE SPECIFIED ROOF SYSTEM WILL BE LISTED IN AN ADDENDUM PRIOR TO BID DATE; ONLY THEN WILL EQUALS BE ACCEPTED AT BIDDING. SUBMITTALS SHALL INCLUDE THE FOLLOWING:

1. Two 3 inch x 5 inch samples of the primary roofing and flashing sheets.
2. Latest edition of the roofing system manufacturer's specifications and installation instructions.
3. Evidence that the manufacturer of the proposed roofing system utilizes a quality management system that is ISO 9001 certified. Documentation of ISO 9001 certification of foreign subsidiaries without domestic certification will not be accepted.
4. Evidence and description of manufacturer's quality control/quality assurance program for the primary roofing products supplied. The quality assurance program description shall include all methods of testing for physical and mechanical property values. Provide confirmation of manufacturer's certificate of analysis (COA) for reporting the tested values of the actual material being supplied for the project prior to issuance of the specified guarantee.
5. Descriptive list of the materials proposed for use.
6. Evidence of Underwriters' Laboratories Class A acceptance of the proposed roofing system (including mopping asphalt or cold adhesive) without additional requirements for gravel or coatings. No other testing agency approvals will be accepted.
7. Evidence that the roof configuration (including fastening of insulation) has been tested by an accredited independent testing agency to meet the design windload pressure indicated in Part 1.07 C2.
8. The roof membrane configuration shall be approved by FM for Class 1-SH (severe hail) exposure.
9. Complete list of material physical and mechanical properties for each sheet including: weights and thicknesses.
10. Sample copy of the proposed guarantee.

B. SUBMITTALS PRIOR TO CONTRACT AWARD:

1. Letter from the proposed primary roofing manufacturer confirming that the bidder is an acceptable Contractor authorized to install the proposed system.
2. Letter from the primary roofing manufacturer stating that the proposed application will comply with the manufacturer's requirements in order to qualify the project for the specified guarantee.

C. SUBMITTALS PRIOR TO PROJECT CLOSE-OUT:

1. Manufacturer's printed recommendations for proper maintenance of the specified roof system including inspection frequencies, penetration addition policies, temporary repairs, and leak call procedures.

1.07. QUALITY ASSURANCE

A. Acceptable Products: Primary roofing products, including each type of sheet, all manufactured in the United States, shall be supplied by a single manufacturer which has been successfully producing the specified types of primary products for not less than 10 years. The primary roofing products shall have maintained a consistent composition for a minimum of five years.

B. Product Quality Assurance Program: Primary roofing materials shall be manufactured under a quality management system that is monitored regularly by a third party auditor under the ISO 9001 audit process. A certificate of analysis (COA) for reporting/confirming the tested values of the actual material being supplied for the project will be required prior to project close-out.

C. Agency Approvals: The proposed roof system shall conform to the following requirements. No other testing agency approvals will be accepted.

1. Evidence by an accredited independent testing agency or agencies that the roof configuration meets a design windload pressure of – 67.5 psf or greater.

D. Acceptable Contractor: Contractor shall have a minimum of 2 years experience in successfully installing the same or similar roofing materials and be certified in writing by the roofing materials manufacturer to install the primary roofing products.

E. Scope of Work: The work to be performed under this specification shall include but is not limited to the following: Attend necessary job meetings and furnish competent and full time supervision, experienced roof mechanics, all materials, tools, and equipment necessary to complete, in an acceptable manner, the roof installation in accordance with this specification. Comply with the latest written application instructions of the manufacturer of the primary roofing products. In addition, application practice shall comply with requirements and recommendations contained in the latest edition of the National Roofing Contractor's Association (NRCA) Roofing Manual as published by the National Roofing Contractor's Association.

F. Local Regulations: Conform to regulations of public agencies, including any specific requirements of the city and/or state of jurisdiction.

G. Manufacturer Requirements: Ensure that the primary roofing materials manufacturer provides direct trained company personnel to attend necessary job meetings, perform periodic inspections as necessary, and conducts a final inspection upon successful completion of the project.

1.08 PRODUCT DELIVERY STORAGE AND HANDLING

A. Delivery: Deliver materials in the manufacturer's original sealed and labeled containers and in quantities required to allow continuity of application.

B. Storage: Refer to the manufacturer's published literature for storage guidelines.

C. Handling: Handle all materials in such a manner as to preclude damage and contamination with moisture or foreign matter. Handle rolled goods to prevent damage to edges or ends.

D. Damaged Material: Any materials that are found to be damaged or stored in any manner other than stated above will be automatically rejected, removed and replaced at the Contractor's expense.

1.09 PROJECT/SITE CONDITIONS

A. Requirements Prior to Job Start

2. Notification: Give a minimum of 5 days notice to the Owner and manufacturer prior to commencing any work and notify both parties on a daily basis of any change in work schedule.

3. Permits: Obtain all permits required by local agencies and pay all fees which may be required for the performance of the work.
 4. Safety: Familiarize every member of the application crew with all fire and safety regulations recommended by OSHA, NRCA and other industry or local governmental groups.
- B. Environmental Requirements
5. Precipitation: Do not apply roofing materials during precipitation or in the event there is a probability of precipitation during application. Take adequate precautions to ensure that materials, applied roofing, and building interiors are protected from possible moisture damage or contamination.
 6. Temperature Restrictions - adhesive: Refer to the manufacturer's published guidelines for temperature restrictions for adhesive applications.
- C. Protection Requirements
7. Membrane Protection: Provide protection against staining and mechanical damage for newly applied roofing and adjacent surfaces throughout this project.
 8. Limited Access: Prevent access by the public to materials, tools and equipment during the course of the project.
 9. Debris Removal: Remove all debris daily from the project site and take to a legal dumping area authorized to receive such materials.
 10. Site Condition: Complete, to the owner's satisfaction, all job site clean-up including building interior, exterior and landscaping where affected by the construction.

1.10 GUARANTEE/WARRANTY

- A. Roof Membrane Guarantee: Upon successful completion of the project, and after all post installation procedures have been completed, furnish the Owner with the manufacturer's 25 year labor and materials membrane guarantee. The guarantee shall be a term type, without deductibles or limitations on coverage amount, and shall be issued at no additional cost to the Owner.
11. Basis of Design > Siplast 25-year Parasolo Roof Membrane/System Guarantee

PART 2 PRODUCTS

2.01 ROOFING SYSTEM ASSEMBLY/PRODUCTS

- A. Rigid Roof Insulation: Roof insulation shall be UL and FM approved. Insulation shall be approved in writing by the insulation manufacturer for intended use and for use with the specified roof assembly.
1. Polyisocyanurate: A closed cell, rigid polyisocyanurate foam core material, integrally laminated between glass fiber reinforced organic facers, in full compliance with ASTM C 1289, Type II, Class 1, Grade 2 (20 psi). Panels shall have a nominal thickness TBD on drawings. Acceptable types are as follows:
 - a. Basis of Design > Paratherm by Siplast; Irving, TX
 2. Gypsum Sheathing Panel: A panel composed of a gypsum based, non-structural water resistant core material integrally bonded with fiberglass mats on both sides having a nominal thickness of 1/4 inch. The panel surface shall be factory primed with a non-asphaltic primer. Acceptable types are as follows:
 - a. DensDeck Prime Gypsum Roof Board, by Georgia Pacific Corporation; Atlanta, GA

2.02 DESCRIPTION OF SYSTEMS

- B. Roof Membrane Ply (fleece-back): A roof membrane consisting of one ply of a prefabricated, polyester scrim-reinforced, polyvinyl chloride (PVC) membrane formulated with an Elvaloy® Ketone Ethylene Ester (KEE) copolymer, applied over a prepared substrate. The roof membrane shall have a factory-adhered polyester fleece backing on the bottom side. The roof membrane shall meet or exceed to the minimum criteria established by ASTM D4434 Standard Specification for Poly(Vinyl Chloride) Sheet Roofing (Type III). The minimum thickness of the roof membrane shall be 80 mils (1.52 mm), as established by ASTM D751 Standard Test Method for Coated Fabrics. The minimum thickness of the roof membrane over the

reinforcement scrim shall be 40 mils (0.685 mm), as established by ASTM D7635 Standard Test Method for Measurement of Thickness of Coatings Over Fabric Reinforcement.

1. Basis of Design > Siplast Parasolo PVC KEE Fleeceback roof system – 80 mil
- C. Flashing Ply (fleece-back): A roof membrane consisting of one ply of a prefabricated, polyester scrim-reinforced, polyvinyl chloride (PVC) membrane formulated with an Elvaloy® Ketone Ethylene Ester (KEE) copolymer, applied over a prepared substrate. The flashing membrane shall have a factory-adhered polyester fleece backing on the bottom side. The flashing system shall meet or exceed to the minimum criteria established by ASTM D4434 Standard Specification for Poly(Vinyl Chloride) Sheet Roofing (Type III). The minimum thickness of the flashing membrane shall be 80 mils as established by ASTM D751 Standard Test Method for Coated Fabrics. The minimum thickness of the flashing membrane over the reinforcement scrim shall be 40 mils as established by ASTM D7635 Standard Test Method for Measurement of Thickness of Coatings Over Fabric Reinforcement.
 1. Basis of Design > Siplast Parasolo PVC KEE smooth detailing membrane – 80 mil
- D. Catalyzed Acrylic Resin Flashing System: A specialty flashing system consisting of a liquid-applied, fully reinforced, multi-component acrylic membrane installed over a prepared or primed substrate. The flashing system consists of a catalyzed acrylic resin primer, basecoat and topcoat, combined with a non-woven polyester fleece. The resin and catalyst are pre-mixed immediately prior to installation. The use of the specialty flashing system shall be specifically approved in advance by the membrane manufacturer for each application.
 1. Basis of Design > Parapro 123 Flashing System by Siplast; Irving, TX
NOTE: Unistrut supports are not a suitable substrate for the Parapro 123 Flashing System. Any unistrut type penetration that is required to be incorporated into the roofing system should be replaced by a solid square or angle iron penetration with a fully welded plate.
- E. Substitute Systems: The following substitute systems shall be considered in lieu of the specified basis of design.
 1. 80 mil FiberTite-SM Fleeceback hybrid roof system by Seaman Corp., Wooster, OH
 2. 80 mil TremPly KEE Fleeceback hybrid roof system by Tremco Roofing and Building Maintenance, Beachwood, OH

2.03 ROOFING ACCESSORIES

- F. Roofing Membrane Adhesives
 1. Fleeceback PVC Membrane Adhesive: A two-part low-rise polyurethane foam adhesive designed for bonding fleece-backed PVC single-ply roofing membranes to various roofing substrates.
 - a. Basis of Design > Parafast T Adhesive by Siplast; Irving, TX
- G. Sealant: A solvent-based, UV resistant synthetic elastomeric sealant for the completion of details.
 1. Basis of Design > Parasolo Flexseal Caulk Grade by Siplast; Irving, TX
- H. Water Block: A single component butyl-based high viscosity sealant for sealing the flashing membrane to the substrate behind exposed termination bars, flashing boots, drain flanges.
 1. Basis of Design > Parasolo Water Block by Siplast; Irving, TX
- I. Membrane Conditioner/Cleaner: A solvent-based agent used to clean exposed or contaminated seams prior to heat welding to remove any residue that may compromise lap welding.
 1. Basis of Design > Parasolo Membrane Conditioner by Siplast; Irving, TX
- J. Membrane Flashing Accessories
 1. Cover Patches at T-Joints: A molded PVC membrane used to reinforce the T-joints of the specified PVC membrane system.
 - a. Basis of Design > Parasolo KEE T-Joint Cover Patch by Siplast; Irving, TX
 2. Pre-formed Boots: A molded PVC membrane used to flash pipe and conduit penetrations having a diameter of 1 to 6 inches (25 to 152 mm). The pre-formed boots shall be hot-air

- welded directly to the PVC roof membrane.
- a. Basis of Design > Parafast KEE Conical Pipe Boot by Siplast; Irving, TX
 3. Outside Corner Flashing: A molded PVC membrane designed to accommodate outside corners of base and curb flashing details. The molded flashing component shall be hot-air welded directly to the specified PVC membrane.
 - a. Basis of Design > Parasolo KEE Outside Corner by Siplast; Irving, TX
 4. Inside Corner Flashing: A molded PVC membrane designed to accommodate inside corners of base and curb flashing details. The molded flashing component shall be hot-air welded directly to the specified PVC membrane.
 - a. Basis of Design > Parasolo KEE Inside Corner by Siplast; Irving, TX
 5. Fluted Corner Flashing: A molded PVC membrane designed to accommodate corners of base and curb flashing details having dimensions that cannot be addressed using standard pre-formed PVC inside or outside corner flashing components. The molded flashing component shall be hot-air welded directly to the specified PVC membrane.
 - a. Basis of Design > Parasolo KEE Fluted Corner by Siplast; Irving, TX
 6. Flashing Strip: An 8-inch wide molded PVC membrane strip designed for general repairs, end laps, and to strip-in PVC coated metal flanges.
 - a. Basis of Design > Parasolo KEE Flashing Strip by Siplast; Irving, TX
 7. Termination Bar with Receiver: An extruded aluminum termination bar with rounded edges and an angled sealant receiver and lower leg bulb stiffener, having factory-punched, slotted holes spaced on 6-inch (152 mm) centers.
 - a. Basis of Design > Parafast Lip Termination Bar 6 inch On Center by Siplast; Irving, TX
 8. Termination Bar with Receiver: An extruded aluminum termination bar with rounded edges and an angled sealant receiver and lower leg bulb stiffener, having factory-punched, slotted holes spaced on 8-inch (203 mm) centers.
 - a. Basis of Design > Parafast Lip Termination Bar 8 inch On Center by Siplast; Irving, TX
 9. Flat Termination Bar: A flat, extruded aluminum termination bar with rounded edges, having factory-punched, slotted holes spaced on 6-inch (152 mm) centers.
 - a. Basis of Design > Parafast Flat Termination Bar 6 inch On Center by Siplast; Irving, TX
 10. Flat Termination Bar: A flat, extruded aluminum termination bar with rounded edges, having factory-punched, slotted holes spaced on 8-inch (203 mm) centers.
 - a. Basis of Design > Parafast Flat Termination Bar 8 inch On Center by Siplast; Irving, TX
 11. PVC Coated Metal: 4-foot by 10-foot sheets of 0.040 aluminum having a factory-laminated PVC coating, used for fabrication into metal gravel stop/drip edge components, base flashings, sealant pans, and scupper sleeves.
 - a. Basis of Design > Parafast PVC Coated Metal by Siplast; Irving, TX
- K. Fasteners
1. Insulation Fasteners: Insulation fasteners and plates shall be FM Approved, and/or approved by the manufacturer of the primary roofing products. The insulation fasteners shall provide attachment required to meet the specified uplift performance and to restrain the insulation panels against the potential for ridging. The fastening pattern for each insulation panel to be used shall be as recommended by the insulation manufacturer and approved by the manufacturer of the primary roofing products. Acceptable insulation fastener manufacturers for specific deck types are listed below.
 - a. Metal Decks: Insulation mechanical fasteners for wood/plywood decks shall be factory coated for corrosion resistance. The fastener shall conform meet or exceed Factory Mutual Standard 4470 and when subjected to 30 Kesternich cycles, show less than 15% red rust. Acceptable insulation fastener types for wood/plywood decks are listed below.

- 1) A fluorocarbon coated screw type roofing fastener having a minimum 0.220 inch thread diameter. Plates used in conjunction with the fastener shall be a metal type having a minimum 3 inch diameter, as supplied by the fastener manufacturer.
 - (a) Basis of Design > Parafast Fastener by Siplast; Irving, TX
- L. Walktread: A prefabricated, extruded and embossed PVC protection pad with a skid-resistant surface.
 1. Thickness: 1/8 inch (3.2 mm)
 2. Width: 30 in (76.2 cm)
 - a. Parasolo Walkway by Siplast; Irving, TX

PART 3 EXECUTION

PREPARATION

- A. General: Sweep or vacuum all surfaces, removing all loose aggregate and foreign substances prior to commencement of roofing.

3.02 ROOF MEMBRANE INSTALLATION

- B. Membrane Application: Apply roofing in accordance with roofing system manufacturer's instructions and the following requirements. Application of roofing membrane components shall immediately follow application of base sheet and/or insulation as a continuous operation.
- C. Aesthetic Considerations: Construction of an aesthetically pleasing overall appearance of the finished roof application is a standard requirement for this project. Make necessary preparations, utilize recommended application techniques, apply the specified materials and exercise care in ensuring that the finished application is acceptable to the Owner.
- D. Membrane Adhesive Application: Membrane adhesive can be applied by roller. Apply cold adhesive in a smooth, even, continuous layer without breaks or voids. Utilize an application rate as published by the roof membrane manufacturer.
- E. Roofing Application: Apply roofing to be free of wrinkles, creases or fishmouths. Use a blower and/or broom to remove any dirt or debris from the substrate surface.
 1. Unroll the specified fleece-back PVC sheets in place and fold back sheets in the long dimension to allow adhering of membrane, one half of sheet at a time. Alternatively, align a full roll of membrane with the factory-applied lap line on the previously installed sheet. Roll out the roll approximately 20 feet (6.1 m) checking to see that the edge of the new roll is straight with the line. Pick up the tail end of the previously rolled-out membrane and pull back over top of the roll of membrane.
 2. Apply the specified low-rise foam adhesive in a "spatter pattern" over the substrate to yield a heavily textured, even coating of approximately 1/4- inch (6.2 mm) to 1/2 inch (12 mm) nominal thickness height on the peaks of the spattered adhesive. Allow the adhesive to rise and apply the roof membrane before the adhesive begins to "skin" over.
 3. Lay half of the membrane into the wet adhesive and roll into place with a 150 lb. (68 kg) roller. Repeat the process for the other half of sheet. If following the alternative method, pull the sheet back to its original position, and roll into place. Make sure that the lap line is followed when re-installing the sheet.
 4. Where the substrate angle changes in excess of 5 degrees (i.e. 1-inch slope), mechanically attach the membrane into the structural deck on [6-inch, 12-inch] centers, keeping the fasteners 1/4 to 3/4 inches from the angle change. At curbs and walls where the angle changes in excess of 10 degrees (i.e. 2-inch slope), mechanically attach the membrane into the structural deck on [6-inch, 12-inch] centers, keeping the fasteners 1/2 inch from the membrane edge. Alternatively, at walls/curbs extend the membrane a minimum of 3 inches up the vertical flashing substrate and mechanically attach the specified lipped termination bar, inverted, at the top edge of the membrane. The termination bar must be installed within 1.5 to 2 inches (38 to 51 mm) of the horizontal plane of the roof, with a minimum of 1-inch (25 mm) of membrane extending above the termination bar. Prior to mechanical attachment of the termination bar, apply the specified

- water block sealant on the flashing substrate where the membrane will terminate. Apply the specified sealant at the top of the termination bar if left exposed.
5. Install a minimum of 4 fasteners evenly spaced around all round, square, "L"-beam or "H"-beam penetrations, keeping the fasteners 1/4 to 3/4 inches from the penetration. At penetrations having a larger diameter, install fasteners around the penetration on 12-inch centers.
 6. Clean the laps of membrane that has become dirty or contaminated using the specified conditioner. Heat weld all side and end laps of the membrane during each day's application. All welds must be continuous, without voids, and free of burns and scorch marks. Weld shall be a minimum width of 1.5 inches (38 mm) for automatic machine welding and 2 inches (51 mm) for hand welding. Contact the manufacturer of the heat-welding equipment for specific guidelines on operating the equipment. Hand-roll the side laps and head laps of the membrane behind the heat welder.
- F. Flashing Application - General: Locate all penetrations at least 24 inches from curbs, walls, and edges to provide access for proper application of the specified flashing materials. Reinforce all coated metal and membrane flashing corners using preformed corners or non-reinforced membrane. Hot-air weld all flashing membranes, accessories, and coated metal to have a minimum 2-inch (51 mm) hand-welded or minimum 1.5-inch (38 mm) automatic machine-welded lap. Reference the manufacturer's standard details for all flashing conditions.
- G. Flashing Application - Coated Metal Flashings: Form coated metal flashings in accordance with the manufacturer's published specifications. Reference the manufacturer's standard details for all flashing conditions. Gap joints of coated metal edge, and flashing sections by a 1/4-inch (6 mm) to allow for expansion and contraction. Apply 2-inch (51 mm) aluminum tape over the joint as a bond-breaker, to prevent welding in this area. Hot-air weld a 6-inch (152 mm) unsupported membrane flashing strip to both sides of the joint, with approximately 1-inch (25 mm) on either side of the joint left un-welded to allow for expansion and contraction. Lap all joints of coated metal sealant pans, scupper inserts, corners of roof edging and base flashing, or pop-rivet a separate metal piece to create a continuous flange condition. Hot-air weld a 6-inch (152 mm) strip of reinforced membrane flashing over all seams that will not be sealed during subsequent flashing installation.
- H. Catalyzed Acrylic Resin Flashing System: Install the liquid-applied primer and flashing system in accordance with the membrane system manufacturer's printed installer's guidelines and other applicable written recommendations as provided by the manufacturer.
- I. Water Cut-Off: At end of day's work, or when precipitation is imminent, construct a water cut-off at all open edges. Cut-offs can be built using asphalt or plastic cement and roofing felts, constructed to withstand protracted periods of service. Cut-offs must be completely removed prior to the resumption of roofing.

3.03 ROOF SYSTEM INTERFACE WITH RELATED COMPONENTS

- J. Walkway/Protection Pads: Install walkway rolls at all roof access locations and other designated locations including roof-mounted equipment, work locations and areas of repeated rooftop traffic. Cut the walktread into maximum 5 foot lengths and allow to relax until flat. Use a minimum spacing of 2 inches between sheets to allow for proper drainage. Heat-weld the walkway rolls to provide a continuous bond around the perimeter edges of the sheet to the roof membrane surface.
- K. Roof Drains: Fit drains with clamping rings and strainer baskets. Provide a minimum 36-inch by 36-inch sump and a slope within the sump not exceeding 4:12. Extend the roof membrane over the drain opening and cut a hole in the membrane directly over the opening, leaving a 1/2-inch of membrane to extending past the drain flange into the drain opening. Punch holes through the roofing membrane at drain bolt locations. Set the membrane in a full bed (i.e. full tube) of the specified water block sealant over the drain flange prior to securement of the clamping ring. Lap seams within the sump area must be avoided. Where lap seams cannot be located outside of the sump area, apply a separate target of the specified roof membrane to extend a minimum of 12-inches in all directions from the sump area and mechanically attached

on 12-inch centers around the drain with the specified screws and plates. Heat weld the flashing target beyond the screws and plates, extending over the drain flange.

- L. Termination Bars: Prior to mechanical attachment of the termination bar, apply the specified water block sealant on the flashing substrate where the membrane will terminate. Mechanically attach termination bars using the specified fasteners. Apply a continuous bead of the specified sealant at the top of termination bars that are fabricated with a sealant receiver lip.

3.04 FIELD QUALITY CONTROL AND INSPECTIONS

- M. Site Condition: Leave all areas around job site free of debris, roofing materials, equipment and related items after completion of job.
- N. Notification Of Completion: Notify the manufacturer by means of manufacturer's printed Notification of Completion form of job completion in order to schedule a final inspection date.
- O. Final Inspection
 - 1. Post-Installation Meeting: Hold a meeting at the completion of the project, attended by all parties that were present at the pre-job conference. A punch list of items required for completion shall be compiled by the Contractor and the manufacturer's representative. Complete, sign, and mail the punch list form to the manufacturer's headquarters.
- P. Issuance Of The Guarantee: Complete all post installation procedures and meet the manufacturer's final endorsement for issuance of the specified guarantee.

END OF SECTION 075419

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**SECTION 075563
VEGETATED PROTECTED MEMBRANE ROOFING**

<<<<<<<< UPDATE NOTES

PART 2 PRODUCTS

END OF SECTION 075563

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**SECTION 077200
ROOF ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Curbs.
- B. Equipment rails.
- C. Roof penetrations mounting curbs.
- D. Non-penetrating pedestals.

1.02 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- C. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process 2021a.
- D. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018.
- E. UL (DIR) - Online Certifications Directory Current Edition.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used.
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Maintenance requirements.
- C. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.
 - 1. Submit shop drawings sealed and signed by a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- D. Warranty Documentation:
 - 1. Submit manufacturer warranty.
 - 2. Ensure that forms have been completed in Owner's name and registered with manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store products under cover and elevated above grade.

1.05 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 ROOF CURBS

- A. Manufactured Curbs:
 - 1. AES Industries Inc; []: www.aescurb.com/#sle.
 - 2. The Pate Company; []: www.patecurbs.com/#sle.
 - 3. Roof Products & Systems (RPS); []: www.rpscurbs.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.

- B. Roof Curbs Mounting Assemblies: Factory fabricated hollow sheet metal construction, internally reinforced, and capable of supporting superimposed live and dead loads and designated equipment load with fully mitered and sealed corner joints welded or mechanically fastened, and integral counterflashing with top and edges formed to shed water.
 - 1. Roof Curb Mounting Substrate: Curb substrate consists of flat roof deck sheathing with insulation.
 - 2. Sheet Metal Material:
 - a. Aluminum: 0.080 inch minimum thickness, with 3003 alloy, and H14 temper.
 - 1) Finish: Clear anodized.
 - 3. Roofing Cants: Provide integral sheet metal roofing cants dimensioned to begin slope at top of roofing system at 1:1 slope; minimum cant height 4 inches.
 - 4. Provide layouts and configurations indicated on drawings.
- C. Curbs Adjacent to Roof Openings: Provide curb on each side of opening, with top of curb horizontal for equipment mounting.
 - 1. Provide preservative treated wood nailers along top of curb.
 - 2. Insulate inside curbs with 1-1/2 inch thick fiberglass insulation.
 - 3. Height Above Finished Roof Surface: 8 inches, minimum.
- D. Equipment Rail Curbs: Straight curbs on each side of equipment, with top of curbs horizontal and level with each other for equipment mounting.
 - 1. Height Above Finished Roof Surface: 8 inches, minimum.
 - 2. Manufacturers:
- E. Pipe, Duct, or Conduit Mounting Curbs: Vertical posts, minimum 8 inches square unless otherwise indicated.
 - 1. Provide sliding channel welded along top edge with adjustable height steel bracket, fabricated to fit item supported.
 - 2. Height Above Finished Roof Surface: 8 inches, minimum.

2.02 NON-PENETRATING ROOFTOP SUPPORTS/ASSEMBLIES

- A. Non-Penetrating Rooftop Support/Assemblies: Manufacturer-engineered and factory-fabricated, with pedestal bases that rest on top of roofing membrane, and not requiring any attachment to roof structure and not penetrating roofing assembly.
 - 1. Design Loadings and Configurations: As required by applicable codes.
 - 2. Height: Provide minimum clearance of 6 inches under supported items to top of roofing.
 - 3. Support Spacing and Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - 4. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - 5. Hardware, Bolts, Nuts, and Washers: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.
- B. Pipe Supports: Provide attachment fixtures complying with MSS SP-58 and as indicated.
 - 1. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
- C. Duct Supports: Provide extruded aluminum supports and sized in accordance with diameter of supported ducts, and with base that is non-penetrating of roofing membrane.
- D. Conduit and Cable Tray Supports:
- E. Non-Penetrating Pedestals: Steel pedestals with square, round, or rectangular bases.
 - 1. Bases: High density polypropylene.
 - 2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - 3. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using methods recommended by manufacturer for achieving acceptable results for applicable substrate under project conditions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions, in manner that maintains roofing system weather-tight integrity.

3.04 CLEANING

- A. Clean installed work to like-new condition.

3.05 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 077200

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**SECTION 078100
APPLIED FIRE PROTECTION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Applied fire protection of interior structural steel not exposed to damage or moisture.
- B. Applied fire protection of structural steel exposed to damage or moisture.
- C. Preparation of applied fire protection for application of exposed overcoat finish specified elsewhere.

1.02 RELATED REQUIREMENTS

- A. Section 051200 - Structural Steel Framing.
- B. Section 078123 - Intumescent Fire Protection.
- C. Section 078400 - Firestopping.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- B. ASTM E605/E605M - Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members 1993, with Editorial Revision (2015).
- C. ASTM E736/E736M - Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members 2019.
- D. ASTM E759/E759M - Standard Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members 1992 (Reapproved 2020).
- E. ASTM E760/E760M - Standard Test Method for Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members 1992 (Reapproved 2020).
- F. ASTM E859/E859M - Standard Test Method for Air Erosion of Sprayed Fire-Resistive Material (SFRMs) Applied to Structural Members 1993 (Reapproved 2020).
- G. ASTM E937/E937M - Standard Test Method for Corrosion of Steel by Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members 1993 (Reapproved 2020).
- H. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015 (Reapproved 2021)e1.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittals procedures.
- B. Product Data: Provide data indicating product characteristics.
- C. Test Reports: Reports from reputable independent testing agencies for proposed products, indicating compliance with specified criteria, conducted under conditions similar to those on project, as follows:
 - 1. Bond strength.
 - 2. Bond impact.
 - 3. Compressive strength.
 - 4. Fire tests using substrate materials similar those on project.
- D. Manufacturer's Installation Instructions: Indicate special procedures.
- E. Manufacturer's Certificate: Certify that sprayed-on fireproofing products meet or exceed requirements of contract documents.
- F. Manufacturer Reports: Indicate environmental conditions that applied fireproofing materials were installed.
- G. Installer's Qualification Statement.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than 5 years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience
 - 1. Having minimum 3 years of documented experience.

1.06 MOCK-UP

- A. Construct mock-up, 100 square feet in size.
- B. Comply with project requirements for fire ratings.
- C. Locate where directed.
- D. Examine installation within one hour of application to determine variances from specified requirements due to shrinkage, temperature, and humidity.
- E. Where shrinkage and cracking are evident, adjust mixture and method of application as necessary; remove materials and re-construct mock-up.
- F. Mock-up may remain as part of the Work.

1.07 FIELD CONDITIONS

- A. Do not apply fireproofing when temperature of substrate material and surrounding air is below 40 degrees F or when temperature is predicted to be below said temperature for 24 hours after application.
- B. Provide ventilation in areas to receive fireproofing during application and 24 hours afterward, to dry applied material.
- C. Provide temporary enclosure to prevent spray from contaminating air.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a two year period after Date of Substantial Completion.
 - 1. Include coverage for fireproofing to remain free from cracking, checking, dusting, flaking, spalling, separation, and blistering.
 - 2. Reinstall or repair failures that occur within warranty period.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Applied Fire Protection:
 - 1. Carboline Company; [____]: www.carboline.com.
 - 2. GCP Applied Technologies; [____]: www.gcpat.com/#sle.
 - 3. Isolatek International Corp; [____]: www.isolatek.com/#sle.
 - 4. Southwest Fireproofing Products Company; [____]: www.sfrm.com/#sle.

2.02 APPLIED FIRE PROTECTION ASSEMBLIES

- A. Provide assemblies as indicated on drawings.

2.03 MATERIALS

- A. Applied Fireproofing Material , interior exposed and concealed applications: Manufacturer's standard factory mixed material, which when combined with water is capable of providing indicated fire resistance, and complying with following requirements:
 - 1. Composition: Gypsum-based; not mineral-fiber-based.
 - 2. Bond Strength: 339 psf, minimum, when tested in accordance with ASTM E736 when set and dry.
 - 3. Dry Density: Minimum average density of 15 lb/cu ft, with minimum individual density of any test sample of 14 lb/cu ft, when tested in accordance with ASTM E605/E605M.
 - 4. Compressive Strength: 1,440 pounds per square inch, minimum.
 - 5. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760/E760M.

6. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E937/E937M.
 7. Air Erosion Resistance: Weight loss of 0, maximum, when tested in accordance with ASTM E859 after 24 hours.
 8. Surface Burning Characteristics: Maximum flame spread index of 0 (zero) and maximum smoke developed index of 0 (zero), when tested in accordance with ASTM E84.
 9. Effect of Deflection: No cracking, spalling, or delamination, when tested in accordance with ASTM E759/E759M.
 10. Fungal Resistance: No growth after 28 days when tested according to ASTM G21.
 11. Manufacturers:
 - a. GCP Applied Technologies; Monokote MK-6: www.gcpat.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- B. Applied Fire Protection Material Exposed to Damage or Moisture: Manufacturer's standard factory mixed material, which when combined with water is capable of providing indicated fire resistance, and complying with following requirements:
1. Basis of Design: Cafco Blaze-Shield II by Isolatek International.
 2. Composition: Portland cement-based; not mineral fiber-based.
 3. Bond Strength: 1,000 psf, minimum, when tested in accordance with ASTM E736/E736M when set and dry.
 4. Dry Density: 16 lb/cu ft, minimum, when tested in accordance with ASTM E605/E605M.
 5. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760/E760M.
 6. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E937/E937M.
 7. Air Erosion Resistance: Weight loss of 0.000g/sf, maximum, when tested in accordance with ASTM E859/E859M after 24 hours.
 8. Surface Burning Characteristics: Maximum flame spread index of 0 (zero) and maximum smoke developed index of 0 (zero), when tested in accordance with ASTM E84.

2.04 ACCESSORIES

- A. Primer Adhesive: Of type recommended by applied fire protection manufacturer.
- B. Water: Clean, potable.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive fireproofing.
- B. Verify that clips, hangers, supports, sleeves, and other items required to penetrate fireproofing are in place.
- C. Verify that ducts, piping, equipment, or other items that would interfere with application of fireproofing have not been installed.
- D. Verify that voids and cracks in substrate have been filled.
- E. Verify that projections have been removed where fireproofing will be exposed to view as a finish material.

3.02 PREPARATION

- A. Perform tests as recommended by fireproofing manufacturer in applications where adhesion of fireproofing to substrate is in question.
- B. Remove incompatible materials that could effect bond by scraping, brushing, scrubbing, or sandblasting.
- C. Prepare substrates to receive fireproofing in strict accordance with instructions of fireproofing manufacturer.
- D. Protect surfaces not scheduled for fireproofing and equipment from damage by overspray, fall-out, and dusting.

- E. Close off and seal duct work in areas where fireproofing is being applied.

3.03 APPLICATION

- A. Apply primer adhesive in accordance with manufacturer's instructions.
- B. Apply fireproofing in uniform thickness and density as necessary to achieve required ratings.

3.04 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 014000 - Quality Requirements.
- B. Inspect installed fireproofing after application and curing for integrity, prior to its concealment.
- C. Ensure that actual thicknesses, densities, and bond strengths meet requirements for specified ratings and requirements of authorities having jurisdiction (AHJ).
- D. Repair or replace applied fireproofing at locations where test results indicate fireproofing does not meet specified requirements.
- E. Re-inspect installed fireproofing for integrity of fire protection, after installation of subsequent Work.

3.05 CLEANING

- A. Remove excess material, overspray, droppings, and debris.
- B. Remove fireproofing from materials and surfaces not required to be fireproofed.
- C. At exposed fireproofing, clean surfaces that have become soiled or stained, using manufacturer's recommended procedures.

END OF SECTION 078100

**SECTION 078123
INTUMESCENT FIRE PROTECTION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Thin-film intumescent mastic fireproofing for exposed structural steel.

1.02 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency current edition.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- C. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials 2020.
- D. SSPC-PA 2 - Procedure For Determining Conformance To Dry Coating Thickness Requirements 2015, with Editorial Revision (2018).

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittals procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Performance characteristics and test results.
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements and recommendations.
 - 4. Installation methods.
- C. Selection Samples: For decorative top coat, color chips representing manufacturer's full range of available colors and sheens.
- D. Verification Samples: For each thickness, color, sheen, and finish required, samples not less than 4 inches square on steel substrate, illustrating finished appearance.
- E. Certificates: Certify that intumescent fireproofing provided for this project meets or exceeds specified requirements in all respects.
- F. Field Quality Control Submittals: Submit field test report.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company that specializes in manufacturing the type of products specified, with minimum of ten years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least five years of documented experience.
- C. MOCK-UP
 - 1. Provide a mock-up for evaluation of surface preparation techniques and application workmanship; approved mock-up will serve as a standard of comparison for subsequent work of this section.
 - 2. Evaluate mock-up for compliance with specified requirements, including thickness and finish texture.
 - 3. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
 - 4. Refinish mock-up area as required to produce acceptable work.
 - 5. Approved mock-up may remain as part of the project.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original, unopened containers with identification labels and testing agency markings intact and legible.
- B. Store products in manufacturer's unopened packaging until ready for installation.
 - 1. Store at temperatures not less than 50 degrees F in dry, protected area.

2. Protect from freezing, and do not store in direct sunlight.
 3. Dispose of any materials that have come into contact with contaminants of any kind prior to application.
- C. Dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.06 FIELD CONDITIONS

- A. Protect areas of application from windblown dust and rain.
- B. Maintain ambient field conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under ambient conditions outside manufacturer's absolute limits.
1. Provide temporary enclosures as required to control ambient conditions.
 2. Do not apply intumescent fireproofing when ambient temperatures are below 50 degrees F without specific approval from manufacturer.
 3. Maintain relative humidity between 40 and 60 percent in areas of application.
 4. Maintain ventilation in enclosed spaces during application and for not less than 72 hours afterward.

PART 2 PRODUCTS

2.01 SYSTEM REQUIREMENTS

- A. Fireproofing: Provide intumescent thin-film fire resistive coating systems tested by an independent testing agency in accordance with ASTM E119 and acceptable to authorities having jurisdiction (AHJ).
1. Provide assemblies listed by UL or FM and bearing listing agency label or mark.
- B. Structural Steel Columns: Fire resistance rating of 2 hours.
- C. Structural Steel Beams: Fire resistance rating of 2 hours.

2.02 MATERIALS

- A. Fire Resistive Coating System: Thin film intumescent mastic fireproofing system for fire protection of structural steel.
1. Surface Burning Characteristics: Tested in accordance with ASTM E84.
 - a. Flame Spread Index (FSI): 25, maximum.
 - b. Smoke Developed Index (SDI): 65, maximum.
 2. For Interior Use:
 - a. Use only products without fiber content.
 - b. VOC Content: Less than 500 g per L when tested in accordance with 40 CFR 59, Subpart D (EPA Method 24).
 - c. Basis of Design: Carboline Company; FIREFILM III C.
 - d. Basis of Design: Carboline Company; Thermo-Lag E100 S.
- B. Coatings as recommended by the fire proofing manufacturer are as follows:
1. Prime Coat: Carbomastic 615 Grey at 4.0 to 8.0 mils dft.
 2. Intumescent: Thermo-Lag E100S at 380 mils dft.
 3. Seal Coat: Carboguard 1340 at 1.0 to 2.0 mils dft.
 4. Finish Coat: Carbothane 133 HB at 3.0 to 5.0 dft. Color to be selected from manufacturer's full range.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates to determine if they are in satisfactory condition to receive intumescent fireproofing; verify that substrates are clean and free of oil, grease, incompatible primers, or other foreign substances capable of impairing bond to fireproofing system.
- B. Do not begin installation until substrates have been properly prepared.

- C. If substrate preparation is responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Thoroughly clean surfaces to receive fireproofing.
- B. Repair substrates to remove surface imperfections that could effect uniformity of texture and thickness of fireproofing system, and remove minor projections and fill voids that could telegraph through finished work.
- C. Cover or otherwise protect other work that might be damaged by fallout or overspray of fireproofing system, and provide temporary enclosures as necessary to confine operations and maintain required ambient field conditions.

3.03 INSTALLATION

- A. Comply with manufacturer's instructions for particular conditions of installation in each case.
- B. Apply manufacturer's recommended primer to required coating thickness.
- C. Apply fireproofing to full thickness over entire area of each substrate to be protected.
- D. Apply coats at manufacturer's recommended rate to achieve dry film thickness (DFT) as required for fire resistance ratings designated for each condition.
- E. Achieve uniform finished appearance complying with approved mock-up.

3.04 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 014000 - Quality Requirements.
 - 1. Arrange for testing of installed intumescent mastic fireproofing by an independent testing laboratory using magnetic pull-off dry film thickness gage in accordance with SSPC-PA 2, and ensure it meets requirements of authorities having jurisdiction (AHJ).
 - 2. Submit field test reports promptly to Contractor and Architect.

3.05 CLEANING

- A. Immediately after installation of fireproofing in each area, remove overspray and fallout from other surfaces and clean soiled areas.

3.06 PROTECTION

- A. Protect installed intumescent mastic fireproofing from damage due to subsequent construction activities, so fireproofing is without damage or deterioration before Date of Substantial Completion.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 078123

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**SECTION 078400
FIRESTOPPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Firestopping of joints and penetrations in fire resistance rated and smoke resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 RELATED REQUIREMENTS

- A. Section 070553 - Fire and Smoke Assembly Identification.
- B. Section 078100 - Applied Fire Protection.

1.03 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials 2020.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).
- C. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems 2015 (Reapproved 2019).
- D. ASTM E2174 - Standard Practice for On-Site Inspection of Installed Firestop Systems 2020a.
- E. ASTM E2393 - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers 2020a.
- F. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus 2020.
- G. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies 2013 (Reapproved 2017).
- H. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015 (Reapproved 2021)e1.
- I. ITS (DIR) - Directory of Listed Products current edition.
- J. FM 4991 - Approval Standard for Firestop Contractors 2013.
- K. FM (AG) - FM Approval Guide current edition.
- L. SCAQMD 1168 - Adhesive and Sealant Applications 1989 (Amended 2017).
- M. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems Current Edition, Including All Revisions.
- N. UL (DIR) - Online Certifications Directory Current Edition.
- O. UL (FRD) - Fire Resistance Directory Current Edition.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- C. Sustainable Design Submittal: Submit VOC content documentation for nonpreformed materials.
- D. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system or fire-resistive joint system, submit illustration, with modifications marked, approved by 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
- E. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

- G. Installer's qualification statement.

1.05 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. All through-penetration firestops shall be provided by one manufacturer.
- D. Installer Qualifications: Company specializing in performing the work of this section and:
1. Trained by manufacturer.
 2. Approved by Factory Mutual Research Corporation under FM 4991, or meeting any two of the following requirements:
 3. Verification of minimum three years documented experience installing work of this type.
 4. Verification of at least five satisfactorily completed projects of comparable size and type.
 5. Licensed by local authorities having jurisdiction (AHJ).
- E. All fire-resistive joints and perimeter fire barriers shall be provided by one manufacturer.

1.06 MOCK-UP

- A. Install one firestopping assembly representative of each fire rating design required on project.
1. Where one design may be used for different penetrating items or in different wall constructions, install one assembly for each different combination.
- B. If accepted, mock-up will represent minimum standard for this work.

1.07 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Firestopping Manufacturers:
1. 3M Fire Protection Products; [____]: www.3m.com/firestop/#sle.
 2. Hilti, Inc; [____]: www.us.hilti.com/#sle.
 3. Specified Technologies Inc; [____]: www.stifirestop.com/#sle.
 4. RectorSeal.
 5. Substitutions: See Section 016000 - Product Requirements.

2.02 MATERIALS

- A. Volatile Organic Compound (VOC) Content: Provide products having VOC content lower than that required by SCAQMD 1168.
- B. Mold and Mildew Resistance: Provide firestopping materials with mold and mildew resistance rating of zero(0) in accordance with ASTM G21.
- C. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.
- D. Fire Ratings: Refer to drawings for required systems and ratings.

2.03 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Perimeter Fire Containment Firestopping: Use system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of floor assembly.

- B. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
- C. Floor-to-Floor (FF), Floor-to-Wall (FW), Head-of-Wall (HW), and Wall-to-Wall (WW) Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
- D. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
 - 1. Temperature Rise: Provide systems that have been tested to show T Rating as indicated.
 - 2. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
 - 3. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

2.04 FIRESTOPPING FOR FLOOR-TO-FLOOR, FLOOR-TO-WALL, HEAD-OF-WALL, AND WALL-TO-WALL JOINTS

2.05 FIRESTOPPING PENETRATIONS THROUGH CONCRETE AND CONCRETE MASONRY CONSTRUCTION

- A. Blank Openings:
 - 1. In Floors or Walls:
 - a. 2 Hour Construction: UL System C-AJ-0090; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - b. 2 Hour Construction: UL System C-AJ-0015; Specified Technologies Inc. SSM mortar.
- B. Penetrations Through Floors or Walls By:
 - 1. Multiple Penetrations in Large Openings:
 - a. 2 Hour Construction: UL System C-AJ-8055; Specified Technologies Inc. SSP Firestop Putty.
 - b. 2 Hour Construction: UL System C-AJ-8114; Specified Technologies Inc. SSM mortar.
 - 2. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System C-AJ-1226; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - 3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System C-AJ-2167; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - b. 2 Hour Construction: UL System C-AJ-2109; Hilti CP 643N/644 Firestop Collar.
 - 4. Electrical Cables Not In Conduit:
 - a. 2 Hour Construction: UL System W-J-3046; Specified Technologies Inc. SSP Firestop Putty.
 - 5. Cable Trays with Electrical Cables:
 - a. 2 Hour Construction: UL System C-AJ-4094; Hilti CFS-BL Firestop Block.
 - 6. Insulated Pipes:
 - a. 2 Hour Construction: UL System C-AJ-5091; Hilti FS-ONE IMAX intumescent Firestop Sealant.
 - 7. HVAC Ducts, Uninsulated:
 - a. 2 Hour Construction: UL System C-AJ-7111; Hilti FS-ONE MAX Intumescent Firestop Sealant.
- C. Penetrations Through Floors By:
 - 1. Multiple Penetrations in Large Openings:
 - a. 2 Hour Construction: UL System F-A-8012; Hilti CFS-S SIL GG Firestop Silicone Sealant Gun-Grade or CFS-S SIL SL Firestop Silicone Sealant Self-Leveling.
 - 2. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System F-A-1016; Hilti CP 680-P/M Cast-In Device.

- b. 2 Hour Construction: UL System F-A-1110; Specified Technologies Inc. CID cast-in devices.
 - 3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System F-A-2065; Hilti CP 680-P Cast-In Device.
 - b. 2 Hour Construction: UL System F-A-2246; Specified Technologies Inc. CID cast-in devices.
 - 4. Insulated Pipes:
 - a. 2 Hour Construction: UL System F-A-5015; Hilti CP 680-P/M Cast-In Device.
 - b. 2 Hour Construction: UL System F-A-5041; Specified Technologies Inc. CID cast-in devices.
 - D. Penetrations Through Walls By:
 - 1. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System W-J-1067; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - b. 1 Hour Construction: UL System W-J-1067; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - 2. Insulated Pipes:
 - a. 2 Hour Construction: UL System C-AJ-5090; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - b. 1 Hour Construction: UL System C-AJ-5090; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - 3. HVAC Ducts, Uninsulated:
 - a. 2 Hour Construction: UL System W-J-7092; Specified Technologies Inc. FyreFlange HVAC Firestop Angle.
 - b. 2 Hour Construction: UL System W-J-7109; Hilti FS-ONE MAX Intumescent Firestop Sealant or CP 606 Flexible Firestop Sealant.
 - 4. HVAC Ducts, Insulated:
 - a. 2 Hour Construction: UL System W-J-7112; Hilti FS-ONE MAX Intumescent Firestop Sealant.

2.06 FIRESTOPPING PENETRATIONS THROUGH GYPSUM BOARD WALLS

- A. Blank Openings:
 - 1. 2 Hour Construction: UL System W-L-0038; Specified Technologies Inc. FP Intumescent Firestop Plug.
 - 2. 2 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
 - 3. 1 Hour Construction: UL System W-L-0038; Specified Technologies Inc. FP Intumescent Firestop Plug.
 - 4. 1 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
- B. Penetrations By:
 - 1. Multiple Penetrations in Large Openings:
 - a. 2 Hour Construction: UL System W-L-1408; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - b. 2 Hour Construction: UL System W-L-8013; Hilti CFS-BL Firestop Block.
 - c. 2 Hour Construction: UL System W-L-8025; Specified Technologies Inc. LCI Intumescent Firestop Sealant.
 - 2. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System W-L-1054; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - b. 1 Hour Construction: UL System W-L-1054; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - 3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System W-L-2078; Hilti CP 643N/644 Firestop Collar.
 - b. 2 Hour Construction: UL System W-L-2128; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - c. 1 Hour Construction: UL System W-L-2078; Hilti CP 643N/644 Firestop Collar.

- d. 1 Hour Construction: UL System W-L-2128; Hilti FS-ONE MAX Intumescent Firestop Sealant.
4. Cable Trays with Electrical Cables:
 - a. 2 Hour Construction: UL System W-L-4011; Hilti CFS-BL Firestop Block.
 - b. 2 Hour Construction: UL System W-L-4060; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - c. 1 Hour Construction: UL System W-L-4011; Hilti CFS-BL Firestop Block.
 - d. 1 Hour Construction: UL System W-L-4060; Hilti FS-ONE MAX Intumescent Firestop Sealant.
5. Insulated Pipes:
 - a. 2 Hour Construction: UL System W-L-5028; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - b. 2 Hour Construction: UL System W-L-5029; Hilti FS-ONE Intumescent Firestop Sealant.
 - c. 1 Hour Construction: UL System W-L-5028; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - d. 1 Hour Construction: UL System W-L-5029; Hilti FS-ONE Intumescent Firestop Sealant.
6. HVAC Ducts, Insulated:
 - a. 2 Hour Construction: UL System W-L-7156; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - b. 2 Hour Construction: UL System W-L-7164; Specified Technologies Inc. FyreFlange HVAC Firestop Angle.
 - c. 1 Hour Construction: UL System W-L-7164; Specified Technologies Inc. FyreFlange HVAC Firestop Angle.
 - d. 1 Hour Construction: UL System W-L-7156; Hilti FS-ONE MAX Intumescent Firestop Sealant.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive the work of this section.
- B. Inspections of through-penetration firestop systems shall be conducted in accordance with the Post-Installation Method outlined in ASTM E 2174. A minimum of 2%, but not less than one, of each type of firestop system shall be inspected per floor or for each area of a floor when a floor is larger than 10,000 square feet.
- C. Inspections of fire-resistive joints and perimeter fire barrier systems shall be conducted in accordance with the Post-Installation Method outlined in ASTM E 2393. A minimum of one sample per 500 lineal feet, but not less than one, of each type of fire-resistive joint shall be inspected.
- D. Destructive testing shall be done in accordance with the International Firestop Counsel's (IFC) IFC Recommended Guidelines for Performing Destructive testing for Installed Penetration Firestop Systems, Fire-Resistive Joint Systems, or Perimeter Fire Barrier Systems dated April 10, 2012.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Install backing materials to prevent liquid material from leakage.

3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by Owner's Independent Testing Agency.

- C. Install labeling required by code.

3.04 FIELD QUALITY CONTROL

- A. Independent Testing Agency: Inspection agency employed and paid by Owner, will examine penetration firestopping in accordance with ASTM E2174 and ASTM E2393.
- B. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.
- C. Where deficiencies are found or firestops are damaged or removed because of testing, repair, or replacing firestopping to comply with requirements:
 - 1. Any type of firestop or fire-resistive joint system does not comply with the inspection documents will require repair or replacement and re-inspection of that firestop/joint system plus one full additional inspection of the percentage specified for that system type. If non-compliance occurs on 10% or more of the quantities of firestop products, systems, or joints, then inspection of those particular types will cease. The installer shall inspect their own work and shall repair or replace those system types with the area prior to commencement of inspections by the inspector.
 - 2. The cost for repair, replacement of tested locations, re-inspection (if required), and retesting (if required), shall be paid for by the contractor and/or sub-contractor. The Owner shall not be responsible for additional costs.
 - 3. The time and expenses for the Special Inspector for Firestop Systems to re-inspect or direct any retests shall be a charge to the Construction Manager based on actual time and expenses, with a minimum charge of \$1,000 per day. The costs associated with re-inspection and/or re-testing shall be paid by the Construction Manager to the Special Inspector. The Construction Manager shall be responsible for any cost recovery for re-inspection and retesting costs from the associated sub-contractor.

3.05 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.06 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 078400

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**SECTION 079200
JOINT SEALANTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nonsag gunnable joint sealants.
- B. Joint backings and accessories.

1.02 REFERENCE STANDARDS

- A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer 2015.
- B. ASTM C794 - Standard Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants 2018.
- C. ASTM C834 - Standard Specification for Latex Sealants 2017.
- D. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications 2018.
- E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
- F. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems 2016.
- G. ASTM C1193 - Standard Guide for Use of Joint Sealants 2016.
- H. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants 2018.
- I. ASTM C1311 - Standard Specification for Solvent Release Sealants 2014.
- J. ASTM C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints 2019 (Reapproved 2020).
- K. SCAQMD 1168 - Adhesive and Sealant Applications 1989 (Amended 2017).

1.03 SUBMITTALS

- A. Product Data for Sealants: Submit manufacturer's technical data sheets for each product to be used, that includes the following.
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 4. Substrates the product should not be used on.
- B. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
- C. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.
- D. Sustainable Design Documentation: For sealants and primers, submit VOC content and emissions documentation; see Section 016116.
- E. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.
- F. Field Quality Control Plan: Submit at least two weeks prior to start of installation.
- G. Field Quality Control Log: Submit filled out log for each length or instance of sealant installed, within 10 days after completion of inspections/tests; include bagged test samples and photographic records, if any.

1.04 QUALITY ASSURANCE

- A. Maintain one copy of each referenced document covering installation requirements on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

- C. Installer Qualifications: Company specializing in performing the work of this section and with at least three years of documented experience.
- D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.
- E. Preconstruction Laboratory Testing: Arrange for sealant manufacturer(s) to test each combination of sealant, substrate, backing, and accessories.
 - 1. Adhesion Testing: In accordance with ASTM C794.
 - 2. Compatibility Testing: In accordance with ASTM C1087.
 - 3. Allow sufficient time for testing to avoid delaying the work.
 - 4. Deliver to manufacturer sufficient samples for testing.
 - 5. Report manufacturer's recommended corrective measures, if any, including primers or techniques not indicated in product data submittals.
 - 6. Testing is not required if sealant manufacturer provides data showing previous testing, not older than 24 months, that shows satisfactory adhesion, lack of staining, and compatibility.
- F. Field Quality Control Plan:
 - 1. Inspection and testing to be performed by the manufacturer's representative.
 - 2. Visual inspection of entire length of sealant joints.
 - 3. Non-destructive field adhesion testing of sealant joints.
 - a. For each different sealant and substrate combination, allow for one test every 12 inches in the first 10 linear feet of joint and one test every 24 inches thereafter.
 - b. If any failures occur in the first 10 linear feet, continue testing at 12 inches intervals at no extra cost to Owner.
 - 4. Field Quality Control Log Form: Show same data fields as on Preinstallation Field Adhesion Test Log, with known information filled out and lines for multiple tests per sealant/substrate combinations; include visual inspection and specified field testing; allow for possibility that more tests than minimum specified may be necessary.
- G. Field Adhesion Test Procedures:
 - 1. Allow sealants to fully cure as recommended by manufacturer before testing.
 - 2. Have a copy of the test method document available during tests.
 - 3. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
 - 4. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.
- H. Non-Destructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Nondestructive Spot Method.
 - 1. Record results on Field Quality Control Log.
 - 2. Repair failed portions of joints.
- I. Field Adhesion Tests of Joints: Test for adhesion using most appropriate method in accordance with ASTM C1521, or other applicable method as recommended by manufacturer.

1.05 WARRANTY

- A. Correct defective work within a five year period after Date of Substantial Completion.
- B. Warranty: Include coverage for installed sealants and accessories that fail to achieve watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.01 JOINT SEALANT APPLICATIONS

- A. Scope:
 - 1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to, the following items.
 - a. Wall expansion and control joints.
 - b. Joints between door, window, and other frames and adjacent construction.

- c. Joints between different exposed materials.
- d. Openings below ledge angles in masonry.
- e. Other joints indicated below.
- 2. Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items.
 - a. Joints between door, window, and other frames and adjacent construction.
 - b. Between plumbing fixtures and wall.
 - c. Between casework and wall.
 - d. In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths.
 - 1) Exception: Through-penetrations in sound-rated assemblies that are also fire-rated assemblies.
 - e. Other joints indicated below.
- 3. Do not seal the following types of joints.
 - a. Joints indicated to be treated with manufactured expansion joint cover or some other type of sealing device.
 - b. Joints where sealant is specified to be provided by manufacturer of product to be sealed.
 - c. Joints where installation of sealant is specified in another section.
 - d. Joints between suspended panel ceilings/grid and walls.
- B. Exterior Joints: Use nonsag non-staining silicone sealant, unless otherwise indicated.
- C. Interior Joints: Use nonsag acrylic latex sealant, unless otherwise indicated.
 - 1. Wall and Ceiling Joints in Non-Wet Areas: Acrylic emulsion latex sealant.
 - 2. Type [] - In Sound-Rated Assemblies: Acrylic emulsion latex sealant.
- D. Interior Wet Areas: Bathrooms, restrooms, kitchens, and food service areas; fixtures in wet areas include plumbing fixtures, food service equipment, countertops, cabinets, and other similar items.
- E. Sound-Rated Assemblies: Walls and ceilings identified as "STC-rated", "sound-rated", or "acoustical".

2.02 JOINT SEALANTS - GENERAL

- A. Sealants and Primers: Provide products having lower volatile organic compound (VOC) content than indicated in SCAQMD 1168.
- B. Colors: As indicated on drawings.

2.03 NONSAG JOINT SEALANTS

- A. Non-Staining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: +100/-50%, minimum.
 - 2. Non-Staining To Porous Stone: Non-staining to light-colored natural stone when tested in accordance with ASTM C1248.
 - 3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
 - 4. Color: To be selected by Architect from manufacturer's standard range.
 - 5. Cure Type: [].
 - 6. Service Temperature Range: Minus 20 to 180 degrees F.
 - 7. Manufacturers:
 - a. Dow Chemical Company; 790 Silicone Building Sealant: consumer.dow.com/en-us/industry/ind-building-construction.html/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- B. ---- Hybrid Silane Polyether for Interior and Exterior Horizontal, Vertical and Overhead Use ----
- C. Acrylic Emulsion Latex: Water-based; ASTM C834, single component, non-staining, non-bleeding, non-sagging; not intended for exterior use.

1. Color: To be selected by Architect from manufacturer's standard range.
2. Grade: ASTM C834; Grade Minus 18 Degrees C (0 Degrees F).
3. Manufacturers:
 - a. Hilti, Inc; CP 506 Smoke and Acoustical Sealant: www.us.hilti.com/#sle.
 - b. Sherwin-Williams Company; 950A Siliconized Acrylic Latex Caulk: www.sherwin-williams.com/#sle.
 - c. Tremco Commercial Sealants & Waterproofing; Tremflex 834: www.tremcosealants.com/#sle.
 - d. Tremco Commercial Sealants & Waterproofing; Tremstop Smoke & Sound: www.tremcosealants.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- D. ---- Unique Water-Based Elastomeric Acrylic Latex, Interior and Exterior Use ----
- E. ---- Unique Acrylic Latex, UL Classified for Use in Fire Rated Systems ----
- F. Butyl Sealant: Solvent-based; ASTM C1311; single component, nonsag; not expected to withstand continuous water immersion or traffic.
 1. Hardness Range: 10 to 30, Shore A, when tested in accordance with ASTM C661.
 2. Color: To be selected by Architect from manufacturer's standard range.
 3. Service Temperature Range: Minus 13 to 180 degrees F.
 4. Manufacturers:
 - a. Sherwin-Williams Company; Storm Blaster All Season Sealant: www.sherwin-williams.com/#sle.

2.04 ACCESSORIES

- A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.
 1. Open Cell: 40 to 50 percent larger in diameter than joint width.
- B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- C. Masking Tape: Self-adhesive, nonabsorbent, non-staining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- D. Joint Cleaner: Non-corrosive and non-staining type, type recommended by sealant manufacturer; compatible with joint forming materials.
- E. Primers: Type recommended by sealant manufacturer to suit application; non-staining.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.

3.02 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.03 INSTALLATION

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform installation in accordance with ASTM C1193.

- C. Perform acoustical sealant application work in accordance with ASTM C919.
- D. Install bond breaker backing tape where backer rod cannot be used.
- E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- F. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- G. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.04 FIELD QUALITY CONTROL

- A. Perform field quality control inspection/testing as specified in PART 1 under QUALITY ASSURANCE article.
- B. Non-Destructive Adhesion Testing: If there are any failures in first 100 linear feet, notify Architect immediately.
- C. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

3.05 POST-OCCUPANCY

- A. Post-Occupancy Inspection: Perform visual inspection of entire length of project sealant joints at a time that joints have opened to their greatest width; i.e. at low temperature in thermal cycle. Report failures immediately and repair.

END OF SECTION 079200

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**SECTION 079513
EXPANSION JOINT COVER ASSEMBLIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Expansion joint cover assemblies for floors, walls, and roofs.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2020.
- B. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2013.
- C. ASTM B308/B308M - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles 2020.
- D. ITS (DIR) - Directory of Listed Products current edition.
- E. UL (DIR) - Online Certifications Directory Current Edition.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide joint assembly profiles, profile dimensions, anchorage devices and available colors and finish.
- C. Manufacturer's Installation Instructions: Indicate rough-in sizes and required tolerances for item placement.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Expansion Joint Cover Assemblies:
 - 1. Construction Specialties, Inc; [____]: www.c-sgroup.com/#sle.
 - 2. MM Systems Corp; [____]: www.mmsystemscorp.com/#sle.
 - 3. Nystrom, Inc; [____]: www.nystrom.com/#sle.
 - 4. Balco< inc.; www.balcousa.com.

2.02 EXPANSION JOINT COVER ASSEMBLY APPLICATIONS

- A. Interior Floor Joints Subject to Thermal Movement:
 - 1. Manufacturer: Construction Specialties, Inc.
 - a. APF.
- B. Interior Floor Joints Subject to Thermal Movement:
 - 1. Manufacturer: Balco, Inc.
 - a. NBAFL
- C. Interior Floor/Wall Joints subject to thermal movement:
 - 1. Manufacturer: Balco, Inc.
 - a. 75VPE
- D. Interior Wall/Ceiling Joints Subject to Thermal Movement:
 - 1. Manufacturers: Emseal Joint Systems, LTD
 - a. Seismic Colorseal.

2.03 EXPANSION JOINT COVER ASSEMBLIES

- A. Expansion Joint Cover Assemblies - General: Factory-fabricated and assembled; designed to completely fill joint openings, sealed to prevent passage of air, dust, water, smoke; suitable for traffic expected.
 - 1. Joint Dimensions and Configurations: As indicated on drawings.

2. Joint Cover Sizes: Selected to suit joint width and configuration, based on manufacturer's published recommendations and limitations.
 3. Joint Cover Styles: As indicated on drawings.
 4. Joint Movement Capability: If not indicated, provide minimum plus/minus 25 percent joint movement capability.
 5. Lengths: Provide covers in full lengths required; avoid splicing wherever possible.
 6. Anchors, Fasteners, and Fittings: Provided by cover manufacturer.
- B. Floor Joint Covers: Coordinate with indicated floor coverings.
1. If floor covering is not indicated, obtain instructions from Architect before proceeding.
 2. If style is not indicated, provide extruded aluminum frame both sides, resilient seals, and minimize exposed metal.
- C. Sliding Cover Plate Type Covers: Provide plate with beveled edges and neat fit that does not collect dirt.
- D. Covers In Gypsum Board Assemblies: Provide style with anchoring wings that can be completely covered by joint compound.
- E. Covers In Fire Rated Assemblies: Provide cover assembly having fire rating equivalent to that of assembly into which it is installed.
1. Acceptable Evaluation Agencies: UL (DIR) and ITS (DIR).

2.04 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper; or ASTM B308/B308M, 6061 alloy, T6 temper.
1. Exposed Finish Outdoors: Natural anodized.
- B. Resilient Seals:
1. For Ceilings: Any resilient material, flush, pleated, or hollow gasket.
 2. For Pedestrian Traffic Applications: EPDM rubber, Neoprene, or Santoprene; no PVC; Shore A hardness of 40 to 50 Durometer.
 3. For Vehicular Traffic Applications: EPDM rubber, Neoprene, or Santoprene; no PVC; Shore A hardness of 40 to 50 Durometer.
 4. Color: To be selected by Architect from manufacturer's full color range.
- C. Anchors and Fasteners: As recommended by cover manufacturer.
- D. Backing Paint for Aluminum Components in Contact with Cementitious Materials: Asphaltic type.
- E. Use LokCrete bedding compound under slip resistant anchor frame to level irregular concrete deck surfaces.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joint preparation and dimensions are acceptable and in accordance with manufacturer's requirements.

3.02 INSTALLATION

- A. Install components and accessories in accordance with manufacturer's instructions.
- B. Align work plumb and level, flush with adjacent surfaces.
- C. Rigidly anchor to substrate to prevent misalignment.

3.03 PROTECTION

- A. Do not permit traffic over unprotected floor joint surfaces.
- B. Provide strippable coating to protect finish surface.

END OF SECTION 079513

**SECTION 081113
HOLLOW METAL DOORS AND FRAMES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Non-fire-rated hollow metal doors and frames.
- B. Hollow metal frames for wood doors.
- C. Fire-rated hollow metal doors and frames.
- D. Thermally insulated hollow metal doors with frames.
- E. Hollow metal borrowed lites glazing frames.

1.02 RELATED REQUIREMENTS

- A. Section 087101 - HARDWARE.
- B. Section 088000 - Glazing: Glass for doors and borrowed lites.
- C. Section 099113 - Exterior Painting: Field painting.
- D. Section 099123 - Interior Painting: Field painting.

1.03 ABBREVIATIONS AND ACRONYMS

- A. ANSI: American National Standards Institute.
- B. HMMA: Hollow Metal Manufacturers Association.
- C. NAAMM: National Association of Architectural Metal Manufacturers.
- D. NFPA: National Fire Protection Association.
- E. SDI: Steel Door Institute.
- F. UL: Underwriters Laboratories.

1.04 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors 2011.
- C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100) 2017.
- D. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames 2011.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- F. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable 2021.
- G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength 2018a.
- H. BHMA A156.115 - American National Standard for Hardware Preparation in Steel Doors and Steel Frames 2016.
- I. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.
- J. ITS (DIR) - Directory of Listed Products current edition.
- K. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames 2002.
- L. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames 2011.
- M. NAAMM HMMA 840 - Guide Specifications For Receipt, Storage and Installation of Hollow Metal Doors and Frames 2007.

- N. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames 2014.
- O. NFPA 80 - Standard for Fire Doors and Other Opening Protectives 2019.
- P. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives 2019.
- Q. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies 2017.
- R. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames 2013.
- S. UL (DIR) - Online Certifications Directory Current Edition.
- T. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies Current Edition, Including All Revisions.
- U. UL 1784 - Standard for Air Leakage Tests of Door Assemblies Current Edition, Including All Revisions.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
- D. Samples: Submit two samples of metal, 2 inch by 2 inch in size showing factory finishes, colors, and surface texture.
- E. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.
- F. Manufacturer's Qualification Statement.
- G. Installer's Qualification Statement.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.
 - 1. Provide hollow metal frames from SDI Certified manufacturer.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
- C. Maintain at project site copies of reference standards relating to installation of products specified.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hollow Metal Doors and Frames:
 - 1. Ceco Door, an Assa Abloy Group company: www.assaabloydss.com.
 - 2. Republic Doors: www.republicdoor.com.
 - 3. Steelcraft, an Allegion brand: www.allegion.com/us.

2.02 PERFORMANCE REQUIREMENTS

- A. Requirements for Hollow Metal Doors and Frames:
 - 1. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM

- A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
2. Accessibility: Comply with ICC A117.1 and ADA Standards.
 3. Exterior Door Top Closures: Flush end closure channel, with top and door faces aligned.
 4. Door Edge Profile: Manufacturers standard for application indicated.
 5. Typical Door Face Sheets: Flush.
 6. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Flush.
 7. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
 8. Zinc Coating for Typical Interior and/or Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvannealed) by the hot-dip process in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness, unless noted otherwise for specific hollow metal doors and frames.
 - a. Based on SDI Standards: Provide at least A40/ZF120 (galvannealed) when necessary, coating not required for typical interior door applications, and at least A60/ZF180 (galvannealed) for corrosive locations.
- B. Hollow Metal Panels: Same construction, performance, and finish as doors.
- C. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL DOORS

- A. Door Finish: Factory primed and field finished.
- B. Exterior Doors: Thermally insulated.
1. Grade: ANSI/SDI A250.8 (SDI-100); Level 3 - Extra Heavy-Duty, Physical Performance Level A, Model 2 - Seamless.
 - a. Physical Performance Level B, 500,000 cycles; in accordance with ANSI/SDI A250.4.
 - b. Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.
 2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
 3. Door Thickness: 1-3/4 inch, nominal.
 4. Door Face Sheets: Flush.
 5. Weatherstripping: Refer to Section 087101.
 6. Door Finish: Factory primed and field finished.
 7. Construction: For exterior locations and elsewhere as indicated, fabricate doors, panels, and frames from metallic-coated steel sheet. Close top and bottom edges of doors flush as an integral part of door construction or by addition of 0.053-inch- thick, metallic-coated steel channels with channel webs placed even with top and bottom edges. Door top shall be seamless.
- C. Interior Doors, Non-Fire Rated:
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 3 - Extra Heavy Duty Commercial.
 - b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Door Face Metal Thickness: 16 gage, 0.053 inch, minimum.
 2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
 3. Door Thickness: 1-3/4 inch, nominal.
 4. Door Face Sheets: Flush.
 5. Door Finish: Factory primed and field finished.

- D. Fire-Rated Doors:
1. Grade: ANSI/SDI A250.8 (SDI-100); Level 3 - Extra Heavy-Duty, Physical Performance Level A, Model 2 - Seamless.
 - a. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
 - b. Door Face Metal Thickness: 16 gage, 0.053 inch, minimum.
 - c. Zinc Coating: A60/ZF180 galvanized coating; ASTM A653/A653M.
 2. Fire Rating: As indicated on Door Schedule, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").
 - a. Temperature-Rise Rating (TRR) Across Door Thickness: In accordance with local building code and authorities having jurisdiction.
 - b. Provide units listed and labeled by UL (DIR) or ITS (DIR).
 - c. Attach fire rating label to each fire rated unit.
 - d. Smoke and Draft Control Doors (Indicated with letter "S" on Drawings and/or Door Schedule): Self-closing or automatic closing doors in accordance with NFPA 80 and NFPA 105, with fire-resistance-rated wall construction rated the same or greater than the fire-rated doors, and the following;
 - 1) Maximum Air Leakage: 3.0 cfm/sq ft of door opening at 0.10 inch w.g. pressure, when tested in accordance with UL 1784 at both ambient and elevated temperatures.
 - 2) Gasketing: Provide gasketing or edge sealing as necessary to achieve leakage limit.
 - 3) Label: Include the "S" label on fire-rating label of door.
 3. Door Core Material: Manufacturers standard core material/construction in compliance with requirements.
 4. Door Thickness: 1-3/4 inch, nominal.
 5. Door Face Sheets: Flush.
 6. Door Finish: Factory primed and field finished.

2.04 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. Frame Finish: Factory primed and field finished.
- C. Exterior Door Frames: Full profile/continuously welded type with sealed top edge.
 1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvanized) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
 2. Frame Metal Thickness: 18 gage, 0.042 inch, minimum.
 3. Frame Finish: Factory primed and field finished.
 4. Weatherstripping: Separate, see Section 087101.
 5. Head: Fully closed top channel at door head.
- D. Interior Door Frames, Non-Fire Rated: Knock-down type.
 1. Frame Metal Thickness: 16 gage, 0.053 inch, minimum.
 2. Frame Finish: Factory primed and field finished.
- E. Door Frames, Fire-Rated: Full profile/continuously welded type.
 1. Fire Rating: Same as door, labeled.
 2. Frame Metal Thickness: 18 gage, 0.042 inch, minimum.
 3. Frame Finish: Factory primed and field finished.
- F. Mullions for Pairs of Doors: Removable type, with profile similar to jambs.
- G. Borrowed Lites Glazing Frames: Construction and face dimensions to match door frames, and as indicated on drawings.
- H. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.

- I. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inch high to fill opening without cutting masonry units.
- J. Frames Wider than 48 inches: Reinforce with steel channel fitted tightly into frame head, flush with top.

2.05 FINISHES

- A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.06 ACCESSORIES

- A. Glazing: as indicated on drawings, factory installed.
- B. Removable Stops: Rolled steel bar, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.
- C. Grout for Frames: Portland cement grout with maximum 4 inch slump for hand troweling; thinner pumpable grout is prohibited.
- D. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
- E. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify that finished walls are in plane to ensure proper door alignment.

3.02 PREPARATION

- A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

3.03 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. Install fire rated units in accordance with NFPA 80.
- C. Coordinate frame anchor placement with wall construction.
- D. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
- E. Install door hardware as specified in Section 087100.
- F. Coordinate installation of electrical connections to electrical hardware items.

3.04 TOLERANCES

- A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.
- B. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.05 ADJUSTING

- A. Adjust for smooth and balanced door movement.

END OF SECTION 081113

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**SECTION 081416
FLUSH WOOD DOORS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flush wood doors; flush configuration; fire rated and non-rated.

1.02 RELATED REQUIREMENTS

- A. Section 081113 - Hollow Metal Doors and Frames.
- B. Section 087101 - HARDWARE.
- C. Section 088000 - Glazing.

1.03 REFERENCE STANDARDS

- A. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass 2018.
- B. AWI (QCP) - Quality Certification Program Current Edition.
- C. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition 2014, with Errata (2016).
- D. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards, U.S. Version 4.0 2021.
- E. NFPA 80 - Standard for Fire Doors and Other Opening Protectives 2019.
- F. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies 2017.
- G. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies Current Edition, Including All Revisions.
- H. UL 1784 - Standard for Air Leakage Tests of Door Assemblies Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- C. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
 - 1. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).
- D. Warranty, executed in Owner's name.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section, with not less than three years of documented experience.
 - 1. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.
- B. Quality Certification:
 - 1. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 2. Provide designated labels on installed products as required by certification program.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Package, deliver and store doors in accordance with specified quality standard.
- B. Accept doors on site in manufacturer's packaging. Inspect for damage.
- C. Protect doors with resilient packaging sealed with heat shrunk plastic. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges with

tinted sealer if stored more than one week. Break seal on site to permit ventilation.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Interior Doors: Provide manufacturer's warranty for the life of the installation.
- C. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Wood Veneer Faced Doors:
 - 1. Eggers Industries; [____]: www.eggersindustries.com/#sle.
 - 2. Graham Wood Doors; [____]: www.grahamdoors.com/#sle.
 - 3. Marshfield DoorSystems, Inc; [____]: www.marshfielddoors.com/#sle.

2.02 DOORS

- A. Doors: Refer to drawings for locations and additional requirements.
 - 1. Quality Level: Custom Grade, Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS).
 - 2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
- B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
 - 1. Provide solid core doors at all locations.
 - 2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with UL 10C - Positive Pressure; Underwriters Laboratories Inc (UL) labeled without any visible seals when door is open.
 - 3. Smoke and Draft Control Doors (Indicated as "S" on Drawings): In addition to required fire rating, provide door assemblies tested in accordance with UL 1784 with maximum air leakage of 3.0 cfm per sq ft of door opening at 0.10 inch wg pressure at both ambient and elevated temperatures for "S" label; if necessary, provide additional gasketing or edge sealing.

2.03 DOOR AND PANEL CORES

- A. Non-Rated Solid Core and 60 Minute Rated Doors: Type structural composite lumber core (SCLC), plies and faces as indicated.
- B. Fire-Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.

2.04 DOOR FACINGS

- A. Veneer Facing for Transparent Finish: White oak, veneer grade in accordance with quality standard indicated, rift cut (only red and white oak), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.
 - 1. Finish: Architect to select from manufacturers full range of color options.

2.05 DOOR CONSTRUCTION

- A. Fabricate doors in accordance with door quality standard specified.
- B. Cores Constructed with stiles and rails:
 - 1. Provide solid blocks at lock edge for hardware reinforcement.
 - 2. Provide solid blocking for other throughbolted hardware.
- C. Glazed Openings: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
- D. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.

- E. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
- F. Provide edge clearances in accordance with the quality standard specified.

2.06 FACTORY FINISHING - WOOD VENEER DOORS

- A. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
 - 1. Transparent:
 - a. System - 9, UV Curable, Acrylated Epoxy, Polyester or Urethane.
 - b. Stain: As selected by Architect.
 - c. Sheen: Satin.
- B. Factory finish doors in accordance with approved sample.
- C. Seal door top edge with color sealer to match door facing.

2.07 ACCESSORIES

- A. Hollow Metal Door Frames: As specified in Section 081113.
- B. Glazed Openings:
 - 1. Heat-Strengthened and Fully Tempered Glass: ASTM C1048.
- C. Glazing Stops: Wood, of same species as door facing, butted corners; prepared for countersink style tamper proof screws.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.02 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
 - 1. Install fire-rated doors in accordance with NFPA 80 requirements.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Use machine tools to cut or drill for hardware.
- D. Coordinate installation of doors with installation of frames and hardware.
- E. Coordinate installation of glazing.
- F. Install door louvers plumb and level.

3.03 TOLERANCES

- A. Comply with specified quality standard for fit and clearance tolerances.
- B. Comply with specified quality standard for telegraphing, warp, and squareness.

3.04 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.

END OF SECTION 081416

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**SECTION 083100
ACCESS DOORS AND PANELS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall access door and frame units.
- B. Ceiling access door and frame units.

1.02 REFERENCE STANDARDS

- A. UL (FRD) - Fire Resistance Directory Current Edition.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 ACCESS DOORS AND PANELS ASSEMBLIES

- A. Wall-Mounted Units:
 - 1. Location: As indicated on drawings.
 - 2. Material: Steel.
 - 3. Wall Mounting Criteria: Provide surface-mounted face frame and door surface flush with frame surface.
- B. Wall-Mounted Units in Wet Areas:
 - 1. Location: As indicated on drawings.
 - 2. Material: Steel, hot-dipped zinc, or zinc-aluminum-alloy coated.
 - 3. Wall Mounting Criteria: Provide surface-mounted face frame and door surface flush with frame surface.
- C. Fire-Rated Wall-Mounted Units:
 - 1. Location: As indicated on drawings.
 - 2. Wall Fire-Rating: As indicated on drawings.
 - 3. Material: Steel.
 - 4. Size: As indicated on drawings.
- D. Ceiling-Mounted Units:
 - 1. Location: As indicated on drawings.
 - 2. Material: Steel.
 - 3. Size: As indicated on drawings.
 - 4. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.

2.02 WALL AND CEILING MOUNTED UNITS

- A. Manufacturers:
 - 1. ACUDOR Products Inc: www.acudor.com/#sle.
 - 2. Babcock-Davis; []: www.babcockdavis.com/#sle.
 - 3. Nystrom, Inc; []: www.nystrom.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Wall and Ceiling Mounted Units: Factory fabricated door and frame, fully assembled units with corner joints welded, filled and ground flush; square and without rack or warp; coordinate requirements with type of installation assembly being used for each unit.
 - 1. Door Style: Single thickness with rolled or turned in edges.
 - 2. Frames: 16 gage, 0.0598 inch, minimum thickness.

3. Heavy Duty Single Steel Sheet Door Panels: 14 gage, 0.0747 inch, minimum thickness.
4. Units in Fire-Rated Assemblies: Fire rating as required by applicable code for fire-rated assembly that access doors are being installed.
 - a. Provide products listed by UL (FRD) as suitable for purpose indicated.
5. Steel Finish: Primed.
6. Primed and Factory Finish: Polyester powder coat; color as selected by Architect from manufacturer's standard colors.
7. Size: Selected from manufacturer's full range.
8. Hardware:
 - a. Hardware for Fire-Rated Units: As required for listing.
 - b. Hinges for Non-Fire-Rated Units: Concealed, constant force closure spring type.
 - c. Latch/Lock: Tamperproof tool-operated cam latch.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings are correctly sized and located.
- B. Begin installation only after substrates have been properly prepared, and if the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Prepare surfaces using methods recommended by manufacturer for applicable substrates in accordance with project conditions.

3.03 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Install frames plumb and level in openings, and secure units rigidly in place.
- C. Position units to provide convenient access to concealed equipment when necessary.

END OF SECTION 083100

**SECTION 083323
OVERHEAD COILING DOORS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Overhead coiling doors and shutters, operating hardware, fire-rated, non-fire-rated, and exterior; manually or electrically operated.
- B. Wiring from electric circuit disconnect to operator to control station.

1.02 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- D. ITS (DIR) - Directory of Listed Products current edition.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- F. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts 2000, with Errata (2008).
- G. NEMA MG 1 - Motors and Generators 2018.
- H. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL (DIR) - Online Certifications Directory Current Edition.
- J. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide general construction, electrical equipment, and component connections and details.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by ITS (DIR), UL (DIR), or testing firm acceptable to authorities having jurisdiction as suitable for purpose specified.

PART 2 PRODUCTS

2.01 COILING DOORS

- A. Exterior Coiling Doors: Steel slat curtain.
 - 1. Refer to structural drawings for required wind load criteria.
 - 2. Sandwich slat construction with insulated core of foamed-in-place polyurethane insulation; minimum R-value of 8.1.
 - 3. Nominal Slat Size: 2 inches wide x required length.
 - 4. Finish: Factory painted, color as selected.
 - 5. Guide, Angles: Galvanized steel.
 - 6. Hood Enclosure: Manufacturer's standard; primed steel.
 - 7. Electric operation.
 - 8. Mounting: Within framed opening.

2.02 MATERIALS AND COMPONENTS

- A. Curtain Construction: Interlocking slats.

1. Slat Ends: Each slat fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
 2. Curtain Bottom: Fitted with angles to provide reinforcement and positive contact in closed position.
 3. Weatherstripping: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure of exterior doors.
- B. Steel Slats: Minimum thickness, 16 gage, [] inch; ASTM A653/A653M galvanized steel sheet.
- C. Guide Construction: Continuous, of profile to retain door in place with snap-on trim, mounting brackets of same metal.
- D. Guides - Angle: ASTM A36/A36M metal angles, size as indicated.
1. Hot-dip galvanized in compliance with ASTM A123/A123M.
- E. Hood Enclosure and Trim: Internally reinforced to maintain rigidity and shape.
- F. Lock Hardware:
1. For motor operated units, additional lock or latching mechanisms are not required.
- G. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb nominal force to operate.

2.03 ELECTRIC OPERATION

- A. Operator, Controls, Actuators, and Safeties: Comply with UL 325; provide products listed by ITS (DIR), UL (DIR), or testing agency acceptable to authorities having jurisdiction.
1. Provide interlock switches on motor operated units.
- B. Electric Operators:
1. Mounting: Side mounted.
2. Motor Enclosure:
a. Exterior Coiling Doors: NEMA MG 1, Type 4; open drip proof.
3. Motor Rating: 1/2 hp; continuous duty.
4. Motor Voltage: 120 volts, single phase, 60 Hz.
5. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.
6. Controller Enclosure: NEMA 250, Type 1.
7. Opening Speed: 12 inches per second.
8. Brake: Adjustable friction clutch type, activated by motor controller.
9. Manual override in case of power failure.
10. Refer to Section 260583 for electrical connections.
- C. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated; enclose terminal lugs in terminal box sized to comply with NFPA 70.
- D. Control Station: Provide standard three button (Open-Close-Stop) momentary-contact control device for each operator complying with UL 325.
1. 24 volt circuit.
2. Surface mounted, at interior door jamb.
3. Entrapment Protection Devices: Provide sensing devices and safety mechanisms complying with UL 325.
a. Primary Device: Provide electric sensing edge, wireless sensing, NEMA 1 photo eye sensors, or NEMA 4X photo eye sensors as required with momentary-contact control device.
- E. Safety Edge: Located at bottom of coiling door, full width, electro-mechanical sensitized type, wired to stop and reverse door direction upon striking object, hollow neoprene covered.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.

- B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
- C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.
- D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
- E. Coordinate installation of electrical service with Section 260583.
- F. Complete wiring from disconnect to unit components.
- G. Install enclosure and perimeter trim.

3.02 TOLERANCES

- A. Maintain dimensional tolerances and alignment with adjacent work.
- B. Maximum Variation From Plumb: 1/16 inch.
- C. Maximum Variation From Level: 1/16 inch.
- D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.03 ADJUSTING

- A. Adjust operating assemblies for smooth and noiseless operation.

3.04 CLEANING

- A. Clean installed components.
- B. Remove labels and visible markings.

END OF SECTION 083323

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**SECTION 084313
ALUMINUM-FRAMED STOREFRONTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aluminum-framed storefront, with vision glass.
- B. Aluminum doors and frames.

1.02 RELATED REQUIREMENTS

- A. Section 087101 - HARDWARE: Hardware items other than specified in this section.
- B. Section 088000 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site 2015.
- B. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document) 2015.
- C. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum 2014 (2015 Errata).
- D. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- E. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) 2014.
- F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2020.
- G. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2013.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, internal drainage details.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
- D. Samples: Submit two samples 12 x 12 inches in size illustrating finished aluminum surface, glass, infill panels, glazing materials.
- E. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
- F. Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.
- G. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
- H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.
- B. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.
- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.09 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

PART 2 PRODUCTS

2.01 BASIS OF DESIGN -- FRAMING FOR MONOLITHIC GLAZING

- A. Center-Set Style:
 - 1. Basis of Design: Kawneer: Trifab VersaGlaze 450 Framing System.
 - 2. Vertical Mullion Dimensions: 1-3/4 inches wide by 4-1/2 inches deep.
- B. Other Manufacturers: Provide either the product identified as "Basis of Design" or an equivalent product of one of the manufacturers listed below:
 - 1. C.R. Laurence Company, Inc; U.S. Aluminum; [____]: www.crl-arch.com/#sle.
 - 2. EFCO, a Pella Company; [____]: www.efcocorp.com/#sle.
 - 3. YKK AP America Inc; [____]: www.ykkap.com/#sle.

2.02 BASIS OF DESIGN -- SWINGING DOORS

- A. Medium Stile, Monolithic Glazing:
 - 1. Basis of Design: Kawneer, Model 350 Medium Stile Entrance.
 - 2. Thickness: 1-3/4 inches.
- B. Other Manufacturers: Provide either the product identified as "Basis of Design" or an equivalent product of one of the manufacturers listed below:
 - 1. C.R. Laurence Company, Inc; U.S. Aluminum; [____]: www.crl-arch.com/#sle.
 - 2. EFCO, a Pella Company; [____]: www.efcocorp.com/#sle.
 - 3. YKK AP America Inc; [____]: www.ykkap.com/#sle.

2.03 STOREFRONT

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Finish: Class II color anodized.
 - a. Factory finish all surfaces that will be exposed in completed assemblies.
 - b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
 - 2. Finish Color: dark bronze.
 - 3. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 - 4. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
 - 5. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
 - 6. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.

7. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
8. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
9. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel and heel bead of glazing compound.

2.04 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior.
 1. Glazing Stops: Flush.
 2. Cross-Section: As indicated on drawings.
- B. Glazing: As specified in Section 088000.
 1. Interior glazed system.
 2. For Interior Framing: Type As indicated on drawings. Tempered or fire rated where required by code..

2.05 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Sheet Aluminum: ASTM B209 (ASTM B209M).
- C. Fasteners: Stainless steel.
- D. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

2.06 FINISHES

- A. Class II Color Anodized Finish: AAMA 611 AA-M12C22A34 Electrolytically deposited colored anodic coating not less than 0.4 mils thick.

2.07 HARDWARE

- A. Other Door Hardware: As specified in Section 087101.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

3.02 INSTALLATION

- A. Install wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
- H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- I. Install hardware using templates provided.
 1. See Section 087101 for hardware installation requirements.

- J. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

- A. Maximum Variation from Plumb: 0.06 inch per 3 feet non-cumulative or 0.06 inch per 10 feet, whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.04 ADJUSTING

- A. Adjust operating hardware and sash for smooth operation.

3.05 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.06 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION 084313

**SECTION 084413
GLAZED ALUMINUM CURTAIN WALLS**

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping: Firestop at system junction with structure.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, internal drainage details, glazing, and infill.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.
- D. Samples: Submit two samples 12 by 12 inches in size illustrating finished aluminum surface, glazing, infill panels, and glazing materials.
- E. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
- F. Design Data: Provide framing member structural and physical characteristics and engineering calculations, and identify dimensional limitations; include load calculations at points of attachment to building structure.
- G. Structural Sealant Glazing (SSG): Submit product data and calculations showing compliance with performance requirements.
- H. Field Quality Control Submittals: Report of field testing for water penetration.
- I. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

- A. Verify that each component is appropriate for use in structural sealant glazing (SSG) application in regards to at least the following properties; size, shape, dimensions, material, self-life, storage conditions, and color.
- B. Manufacturer and Installer Qualifications: Company specializing in manufacturing aluminum glazing systems with minimum 5 years of documented experience.

1.05 MOCK-UP

- A. See Section 014000 - Quality Requirements, for general requirements for mock-ups.
- B. Locate on-site where directed by Architect; mock-up may remain as part of the Work.
 - 1. Mock up size: 1 frame, 5' wide by 5' high.
 - 2. Field Test: Conduct field test of mock up to determine watertightness in accordance with AAMA 503.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.
- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.07 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- D. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 BASIS OF DESIGN - CURTAIN WALL SYSTEMS

- A. Wind-Borne-Debris Resistance Tested:
 - 1. Basis of Design: Kawneer 1600 Wall System 1 Curtain Wall.
 - a. Glazing configuration: thermally broken, outside glazed.
 - b. Sight line: 2 -1/2 inches
 - c. System depth: 6 inches

2.02 CURTAIN WALL

- A. Aluminum-Framed Curtain Wall: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Finish: Class II natural anodized.
 - a. Factory finish surfaces that will be exposed in completed assemblies.
 - b. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
 - 2. Provide flush joints and corners, weathersealed, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 - 3. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
 - 4. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
- B. Structural Performance Requirements: Design and size components to withstand the following load requirements without damage or permanent set.
 - 1. Movement: Accommodate the following movement without damage to components or deterioration of seals:
 - a. Expansion and contraction caused by 180 degrees F surface temperature.
 - b. Expansion and contraction caused by cycling temperature range of 170 degrees F over a 12 hour period.
 - c. Movement of curtain wall relative to perimeter framing.
 - d. Deflection of structural support framing, under permanent and dynamic loads.
- C. Air Leakage Laboratory Test: Maximum of 0.06 cu ft/min sq ft of wall area, when tested in accordance with ASTM E283 at 6.27 psf pressure differential across assembly.
- D. Thermal Performance Requirements:
 - 1. Condensation Resistance Factor of Framing: 65, minimum, measured in accordance with AAMA 1503.
 - 2. Overall U-value Including Glazing: 0.37 Btu/(hr sq ft deg F), maximum.

2.03 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
- B. Glazing: As specified in Section 088000.

2.04 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Sheet Aluminum: ASTM B209 (ASTM B209M).
- C. Fasteners: Stainless steel; type as required or recommended by curtain wall manufacturer.
- D. Firestopping: As specified in Section 078400.
- E. Structural Sealant Glazing (SSG) Adhesive: Neutral curing, silicone sealant formulated for SSG applications in compliance with ASTM C1184 and structural glazing industry guidelines, ASTM C1401.
 - 1. SSG adhesive in compliance with ASTM C920; Type S - Single-component, Grade NS, Class 50, Use NT, G, and A.
 - 2. Ultimate Tensile Strength: Minimum of 50 psi as determined by test method ASTM C1135 under the following conditions.
 - a. Exposure to air temperatures of 190 degrees F and minus 20 degrees F.
 - b. Water immersion for seven (7) days, minimum.
 - c. Exposure to weathering for 5,000 hours, minimum.
 - 3. Sealant Design Tensile Strength: 20 psi, maximum.
 - 4. Hardness: 20 to 60 with Type A-2 durometer in compliance with test method ASTM C661.
 - 5. SSG sealant tested for compatibility with glazing accessories in compliance with ASTM C1087, tested for accelerated weathering in compliance with ASTM C793, and in compliance with insulating glass secondary sealant design standards of ASTM C1249.
 - 6. Manufacturers:
 - a. Provide product recommended by curtain wall manufacturer.
- F. Weatherseal Sealant: Silicone, with adhesion in compliance with ASTM C794; compatible with glazing accessories.
- G. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
- H. Glazing Accessories: As specified in Section 088000.

2.05 FINISHES

- A. Custom color: Valspar Fluropon "Antique Bronze (397 x 364)

2.06 PART 3 EXECUTION

2.07 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other related work.
- B. Verify that curtain wall openings and adjoining air and vapor seal materials are ready to receive work of this section.
- C. Verify that anchorage devices have been properly installed and located.

2.08 INSTALLATION

- A. Install curtain wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Install firestopping at each floor slab edge.
- H. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

2.09 TOLERANCES

- A. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 0.5 inches per 100 ft, whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.
- C. Sealant Space Between Curtain Wall Mullions and Adjacent Construction: Maximum of 3/4 inch and minimum of 1/4 inch.

2.10 FIELD QUALITY CONTROL

- A. Provide services of curtain wall manufacturer's field representative to observe for proper installation of system and submit report.
- B. Provide field testing of installed curtain wall system by independent laboratory in accordance with AAMA 503 during construction process and before installation of interior finishes.
 - 1. Perform a minimum of two tests in each designated area as directed by Architect.
 - 2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.
 - 3. Field test for water penetration in accordance with ASTM E1105 with uniform static air pressure difference (Procedure A) not less than 4.18 psf.
- C. Repair or replace curtain wall components that have failed designated field testing, and retest to verify performance complies with specified requirements.

2.11 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, take care to remove dirt from corners, and wipe surfaces clean.
- C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

2.12 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION 084413

**SECTION 084435
PROTECTIVE FRAMED GLAZING ASSEMBLIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior protective framed glazing assembly.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping: Firestop at exterior wall assembly junction with structure.
- B. Section 079200 - Joint Sealants: Sealing joints between frames and adjacent construction.
- C. Section 087101 - HARDWARE: Hardware installation requirements.
- D. Section 087101 - HARDWARE.

1.03 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site 2015.
- B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum 2014 (2015 Errata).
- C. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix) 2017a.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2020.
- F. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials 2020.
- G. FM (AG) - FM Approval Guide current edition.
- H. ITS (DIR) - Directory of Listed Products current edition.
- I. NFPA 80 - Standard for Fire Doors and Other Opening Protectives 2019.
- J. UL (DIR) - Online Certifications Directory Current Edition.
- K. UL 263 - Standard for Fire Tests of Building Construction and Materials Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide evidence of compliance with fire performance criteria and manufacturer's published product data on framing components, glazing, anchorage and fasteners, and doors, if any.
- C. Design Data: Submit framing member structural and physical characteristics and engineering calculations, and identify dimensional limitations.
- D. Test Reports: Submit results of full-size mock-up testing for criteria other than fire performance. Reports of tests previously performed on the same design are acceptable.
- E. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
- F. Manufacturer's Qualification Statement.
- G. Installer's Qualification Statement.
- H. Warranty Documentation: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with at least ten years documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.
- B. Protect finished surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to substrate when exposed to sunlight or weather.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

PART 2 PRODUCTS

2.01 INTERIOR PROTECTIVE FRAMED GLAZING ASSEMBLIES

- A. Basis of Design: FireFrames Designer Series by TGP Fire-Rated steel frame series as manufactured by Technical Glass Products.
- B. Provide factory fabricated, factory finished framing members with glazing and related flashings, anchorage and attachment devices.
- C. Fire Performance: Provide hourly fire-resistance-rating as indicated; tested as an assembly including glazing in compliance with ASTM E119 or UL 263 and requirements of local authorities having jurisdiction.
 - 1. Acceptable evidence of compliance includes listing by UL (DIR), ITS (DIR), or testing agency acceptable to authorities having jurisdiction.

2.02 COMPONENTS

- A. Framing Members: Formed steel structural members without aluminum cladding and non-combustible thermally-resistive material as required for fire rating.
 - 1. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 - 2. Glazing Stops: Flush.
 - 3. Cross-Section: As indicated on drawings.
 - 4. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.

2.03 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Structural Steel Sections: ASTM A36/A36M; shop primed.
- C. Structural Supporting Anchors Attached to Structural Steel: Design for bolted attachment.
- D. Firestopping: See Section 078400.
- E. Sealants Within Fire-Rated Assembly: As required by fire-rating and manufacturer's assembly.
- F. Sealants: See Section 079200 for additional information.
- G. Glazing Gaskets: Type to suit application to achieve fire-rating, weather, moisture, and air infiltration requirements.
- H. Shop and Touch-Up Primer for Steel Components: Zinc oxide, alkyd, linseed oil primer appropriate for use over hand cleaned steel.

2.04 DOORS AND HARDWARE

- A. Doors: Glazed wood.
 - 1. Thickness: 1-3/4 inches.
 - 2. Top Rail: 6 inches wide.
 - 3. Vertical Stiles: 8 inches wide.
 - 4. Bottom Rail: 13 inches wide.
 - 5. Glazing Stops: Square.
 - 6. Finish: Same as framing.
- B. Door Hardware:
 - 1. Types: See Section 087101.
 - 2. Finish on Hand-Contacted Items: Polished chrome.
- C. Interior Doors:
 - 1. Hinges: Butt type, swing clear; top and bottom.

2.05 FINISHES

- A. Finishing: Apply factory finish to surfaces that will be exposed in completed assemblies.
 - 1. Touch-up surfaces cut during fabrication so that no natural metal surfaces are visible in completed assemblies, including joint edges.
- B. High Performance Organic Coatings: AAMA 2604; multiple coats, thermally cured fluoropolymer system.
- C. Color: As selected by Architect from manufacturer's standard range.
- D. Touch-Up Materials: As recommended by coating manufacturer for field application.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install wall system in accordance with limitations of fire rating and with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Install door hardware using templates provided.
 - 1. See Section 087101 for hardware installation requirements.
- H. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.02 ADJUSTING

- A. Adjust doors for smooth operation.

END OF SECTION 084435

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SECTION 087100
DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
1. Swinging doors.
 2. Sliding doors.
 3. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
1. Mechanical door hardware.
 2. Electromechanical door hardware.
 3. Cylinders specified for doors in other sections.
- C. Related Sections:
1. Division 06 Section "Rough Carpentry".
 2. Division 06 Section "Finish Carpentry".
 3. Division 08 Section "Operations and Maintenance".
 4. Division 08 Section "Door Schedule".
 5. Division 08 Section "Hollow Metal Doors and Frames".
 6. Division 08 Section "Flush Wood Doors".
 7. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 2. ANSI/SDI A250.13 - Testing and Rating of Severe Windstorm Resistant Components for Swing Door Assemblies.
 3. ASTM E1886 - Test Method for Performance of Exterior Windows, Curtain Walls, Doors and Shutters Impacted by Missiles and Exposed to Cyclic Pressure Differentials.
 4. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure difference.

5. ASTM E1996 - Standard specification for performance of exterior windows, curtain walls, doors and storm shutters impacted by Windborne Debris in Hurricanes.
 6. ICC/IBC - International Building Code.
 7. NFPA 70 - National Electrical Code.
 8. NFPA 80 - Fire Doors and Windows.
 9. NFPA 101 - Life Safety Code.
 10. NFPA 105 - Installation of Smoke Door Assemblies.
 11. TAS-201-94 - Impact Test Procedures.
 12. TAS-202-94 - Criteria for Testing Impact and Non-Impact Resistant Building Envelope Components using Uniform Static Air Pressure.
 13. TAS-203-94 - Criteria for Testing Products Subject to Cyclic Wind Pressure Loading.
 14. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:
1. ANSI/BHMA Certified Product Standards - A156 Series.
 2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
 3. ANSI/UL 294 - Access Control System Units.
 4. UL 305 - Panic Hardware.
 5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.

- b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
 1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
 2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Proof of Qualification: Provide copy of manufacturer(s) Factory Trained Installer documentation indicating proof of status as a qualified installer of Windstorm assemblies.
- E. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- F. Informational Submittals:
 1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

- G. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).
- C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- E. Windstorm Assembly Installer Qualifications: Installers are to be factory trained for shop and field installation prior to project bid, and are responsible for commissioning, servicing, and warranting the installed equipment specified for the project. A pre-installation site inspection of the frame and floor conditions shall be conducted by the factory trained installer prior to any Windstorm assembly hardware applied to the opening.
- F. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
 - 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 - 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- G. Hurricane Resistant Exterior Openings (State of Florida including the High Velocity Hurricane Zone (HVHZ)): Provide exterior door hardware as complete and tested assemblies, or component assemblies, including approved doors and frames specified

under Section 081113 "Hollow Metal Doors and Frames", to meet the wind loads, design pressures, debris impact resistance, and glass and glazing requirements as detailed in the current State of Florida building code sections applicable to the Project.

1. Each unit to bear third party permanent label in accordance with the Florida Building Code requirements.
 - H. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
 - I. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
 1. Function of building, purpose of each area and degree of security required.
 2. Plans for existing and future key system expansion.
 3. Requirements for key control storage and software.
 4. Installation of permanent keys, cylinder cores and software.
 5. Address and requirements for delivery of keys.
 - J. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
 1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 3. Review sequence of operation narratives for each unique access controlled opening.
 4. Review and finalize construction schedule and verify availability of materials.
 5. Review the required inspecting, testing, commissioning, and demonstration procedures
 - K. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
 - 1. Ten years for mortise locks and latches.
 - 2. Seven years for heavy duty cylindrical (bored) locks and latches.
 - 3. Five years for exit hardware.

4. Five years for manual overhead door closer bodies.
5. Twenty five years for manual overhead door closer bodies.
6. Five years for motorized electric latch retraction exit devices.
7. Two years for electromechanical door hardware.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
 1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
 1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
 5. Manufacturers:
 - a. Hager Companies (HA).
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
 - c. Stanley Hardware (ST).
- B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.
1. Manufacturers:
 - a. Bommer Industries (BO).
 - b. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.3 POWER TRANSFER DEVICES

- A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
 1. Manufacturers:
 - a. Hager Companies (HA) - ETW-QC (# wires) Option.

- b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - QC (# wires) Option.
 - c. Stanley Hardware (ST) - C Option.
 - B. Electrified Quick Connect Continuous Geared Transfer Hinges: Provide electrified transfer continuous geared hinges with a removable service panel cutout accessible without de-mounting door from the frame. Furnish with Molex™ standardized plug connectors with sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
 1. Manufacturers:
 - a. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE) - SER-QC (# wires) Option.
 - C. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.
 1. Provide one each of the following tools as part of the base bid contract:
 - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Electrical Connecting Kit: QC-R001.
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Connector Hand Tool: QC-R003.
 2. Manufacturers:
 - a. Hager Companies (HA) - Quick Connect.
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - QC-C Series.
 - c. Stanley Hardware (ST) - WH Series.

2.4 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.
 1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
 2. Furnish dust proof strikes for bottom bolts.

3. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
 4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
 5. Manufacturers:
 - a. Door Controls International (DC).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).
- B. Coordinators: ANSI/BHMA A156.3 certified door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Model as indicated in hardware sets.
1. Manufacturers:
 - a. Door Controls International (DC).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).
- C. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
 2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
 3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
 4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
 5. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.5 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
- B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:

1. Threaded mortise cylinders with rings and cams to suit hardware application.
2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
4. Tubular deadlocks and other auxiliary locks.
5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
6. Keyway: Manufacturer's Standard.

C. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. New System: Key locks to a new key system as directed by the Owner.

D. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).

E. Construction Keying: Provide construction master keyed cylinders.

F. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

2.6 KEY CONTROL

A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:
 - a. Lund Equipment (LU).
 - b. MMF Industries (MM).
 - c. Telkee (TK).

2.7 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be

manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ML2000 Series.
 - b. dormakaba Best (BE) - 45H Series.
 - c. Sargent Manufacturing (SA) - 8200 Series.

2.8 ELECTROMECHANICAL LOCKING DEVICES

A. Electromechanical Cylindrical Locksets, Grade 1 (Heavy Duty): Subject to same compliance standards and requirements as mechanical cylindrical locksets, electrified locksets to be of type and design as specified below.

1. Electrified Lock Options: Where indicated in the Hardware Sets, provide electrified options including: outside door lock/unlock trim control and request-to-exit signaling. Unless otherwise indicated, provide electrified locksets standard as fail secure.
2. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - CL33900 Series.
 - b. dormakaba Best (BE) - 93K EL/EU Series.
 - c. Sargent Manufacturing (SA) - 10G70/71 Series.

2.9 AUXILIARY LOCKS

2.10 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.

4. Dustproof Strikes: BHMA A156.16.

2.11 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
5. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
 - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
6. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
7. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
8. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
9. Rail Sizing: Provide exit device rails factory sized for proper door width application.
10. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

11. Hurricane and Tornado Resistance Compliance: Conventional exit devices are to be U.L. listed for windstorm assemblies where applicable. Provide the appropriate hurricane or tornado resistant products that have been independent third party tested, certified, and labeled to meet state and local windstorm building codes applicable to project.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
 1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
 - b. Sargent Manufacturing (SA) - 80 Series.
 - c. Von Duprin (VD) - 35A/98 XP Series.

2.12 ELECTROMECHANICAL EXIT DEVICES

- A. Electromechanical Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices subject to same compliance standards and requirements as mechanical exit devices. Electrified exit devices to be of type and design as specified below and in the hardware sets.
 1. Energy Efficient Design: Provide devices which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
 2. Where conventional power supplies are not sufficient, include any specific controllers required to provide the proper inrush current.
 3. Motorized Electric Latch Retraction: Devices with an electric latch retraction feature must use motors which have a maximum current draw of 600mA. Solenoid driven latch retraction is not acceptable.
 4. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ED5000 Series.
 - b. Sargent Manufacturing (SA) - 80 Series.
 - c. Von Duprin (VD) - 35A/98 XP Series.

2.13 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
 2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
 4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.
1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - DC8000 Series.
 - b. Norton Door Controls (NO) - 9500 Series.
 - c. Sargent Manufacturing (SA) - 281 Series.
- C. Door Closers, Overhead Concealed (Narrow Profile): ANSI/BHMA 156.4 Grade 1 Certified Products Directory (CPD) listed door closers designed for narrow profile frames and doors. Closers to have fully concealed body in the frame head for offset hung applications, with separate and independent valves for closing speed and backcheck adjustments and a decorative cover plate.
1. Manufacturers:
 - a. LCN Closers (LC) - 2030 Series.
 - b. Rixson Door Controls (RF) - 91DCP Series.

2.14 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, .050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.15 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 1. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.16 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 - 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
 - 1. National Guard Products (NG).
 - 2. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
 - 3. Reese Enterprises, Inc. (RE).

2.17 ELECTRONIC ACCESSORIES

- A. Networked Proximity Card Readers: Card readers to support HID 125 kHz proximity technology and interface with the access control reader modules and door control hardware devices as specified. Card readers to meet the following, minimum, design and performance specifications.
 - 1. Reader to operate on 12VDC or 5VDC power from the reader I/O modules at a maximum current rating of 150 mA per reader.
 - 2. Reader to be weatherproof type when installed in exterior or other wet environments.
 - 3. Reader to communicate with the reader I/O modules using industry standard Wiegand protocol interface.
 - 4. Reader to have multi-color LED display and audible status indications.

5. Reader type and model to meet the design and mounting applications needs of each entry point as indicated on the drawings.
6. Manufacturers (125 kHz Proximity):
 - a. HID Global (HG) - MiniProx 5365/ProxPro II 5455 Series.
- B. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.
 1. Manufacturers:
 - a. Securitron (SU) - DPS Series.
- C. Intelligent Switching Power Supplies: Provide power supplies with single, dual or multi-voltage configurations at 12 and/or 24VDC. Power Supply shall have battery backup function with an integrated battery charging circuit. The power supply shall have a standard, integrated Fire Alarm Interface (FAI). The power supply shall provide capability for secondary voltage, power distribution, direct lock control and network monitoring through add on modules. The power supply shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs. Network modules shall provide remote monitoring functions such as status reporting, fault reporting and information logging.
 1. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.
 2. Manufacturers:
 - a. Securitron (SU) - AQL Series.

2.18 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.19 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."

4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.

- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

- B. Manufacturer's Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. RU - Corbin Russwin
4. RO - Rockwood
5. AD - Adams Rite
6. RF - Rixson
7. SU - Securitron

Hardware Sets

Set: 1.0

Doors: D100

Description: EXT PR - ALUM - EAC

1 Continuous Hinge	CFMXXHD1		PE	087100	
1 Continuous Hinge (Elec)	CFMXXHD1 SER		PE	087100	⚡
1 Concealed Vert Rod Exit, Exit Only	ED4800 EO	630	RU	087100	
1 Concealed Vert Rod Exit, Storeroom	ED4800 O859ET M92 MELR	630	RU	087100	⚡
1 Cylinder	As required	626	RU	087100	
2 Door Pull	BF168	US32D	RO	087100	
2 Concealed Closer	91N / PH91 - 90N [special template]	626	RF	087100	
2 Door Stop	480H	US26D	RO	087100	
1 Threshold	2005AT MSES25SS		PE	087100	
1 Gasketing	by door / frame mfg				
1 ElectroLynx Harness	QC-C1500 [PS to hinge]		MK	087100	⚡
1 ElectroLynx Harness	QC-CXXP [Lock / exit to hinge]		MK	087100	⚡
1 Card Reader	SE RP40 / SE RP15 as req			087100	⚡
1 Position Switch	DPS-M/W-WH (as required)		SU	087100	⚡
1 Power Supply	AQLX-E1 - Size as required		SU	087100	⚡

Notes: Hardware listed for design criteria, confirm with specific door manufacturer the hardware requirements to meet specified windstorm rating - Provide 3rd party test results for confirmation.

Set: 1.1

Doors: D100G, DS1001-2

Description: EXT PR - ALUM

2 Continuous Hinge	CFMXXHD1		PE	087100	
1 Concealed Vert Rod Exit, Storeroom	ED4800 O859ET	630	RU	087100	
1 Concealed Vert Rod Exit, Exit Only	ED4800 EO	630	RU	087100	
1 Cylinder	As required	626	RU	087100	

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2 Door Pull	BF168	US32D	RO	087100
2 Concealed Closer	91N / PH91 - 90N [special template]	626	RF	087100
2 Door Stop	480H	US26D	RO	087100
1 Threshold	2005AT MSES25SS		PE	087100
1 Gasketing	by door / frame mfg			

Notes: Hardware listed for design criteria, confirm with specific door manufacturer the hardware requirements to meet specified windstorm rating - Provide 3rd party test results for confirmation.

Set: 2.0

Doors: D100H

Description: EXT CORR - ALUM - EAC

1 Continuous Hinge (Elec)	CFMXXHD1 SER		PE	087100	⚡
1 Rim Exit Device, Nightlatch	ED4200 K157ET M92 MELR	630	RU	087100	⚡
1 Cylinder	As required	626	RU	087100	
1 Door Pull	BF168	US32D	RO	087100	
1 Concealed Closer	91N / PH91 - 90N [special template]	626	RF	087100	
1 Door Stop	480H	US26D	RO	087100	
1 Threshold	2005AT MSES25SS		PE	087100	
1 Gasketing	by door / frame mfg				
1 ElectroLynx Harness	QC-C1500 [PS to hinge]		MK	087100	⚡
1 ElectroLynx Harness	QC-CXXP [Lock / exit to hinge]		MK	087100	⚡
1 Card Reader	SE RP40 / SE RP15 as req			087100	⚡
1 Position Switch	DPS-M/W-WH (as required)		SU	087100	⚡
1 Power Supply	AQLX-E1 - Size as required		SU	087100	⚡

Notes: Door normally closed and secured.

Authorized credential retracts the latchbolt to allow free entry, door relocks upon closing. REX (request to exit) switch in device rail allow for free exit at all times

Entry by key override at all times

Door is fail secure

Hardware listed for design criteria, confirm with specific door manufacturer the hardware requirements to meet specified windstorm rating - Provide 3rd party test results for confirmation.

Set: 3.0

Doors: D129C

Description: EXT BREAK - ALUM

1 Continuous Hinge	CFMXXHD1		PE	087100
1 Deadlatch	4900 X 4591	628	AD	087100
1 Cylinder	As required	626	RU	087100
2 Door Pull	BF168	US32D	RO	087100
1 Concealed Closer	91N / PH91 - 90N [special template]	626	RF	087100
1 Door Stop	480H	US26D	RO	087100
1 Threshold	2005AT MSES25SS		PE	087100
1 Gasketing	by door / frame mfg			
1 Position Switch	DPS-M/W-WH (as required)		SU	087100 ⚡

Notes: Door normally closed and secured.

Authorized credential retracts the latchbolt to allow free entry, door relocks upon closing. REX (request to exit) switch in device rail allow for free exit at all times

Entry by key override at all times

Door is fail secure

Hardware listed for design criteria, confirm with specific door manufacturer the hardware requirements to meet specified windstorm rating - Provide 3rd party test results for confirmation.

Set: 4.0

Doors: D116A

Description: EXT ELEC - PR

8 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK	087100
1 Mullion	CRWS708AKM		RU	087100
1 Rim Exit Device, Exit Only	ED5200 EO M107	630	RU	087100
1 Rim Exit Device, Nightlatch	ED5200 PR957ET M107	630	RU	087100
2 Cylinder	As required	626	RU	087100
2 Surface Closer	DC8210 A11	689	RU	087100
2 Kick Plate	K1050 10" X 2" LDW	US32D	RO	087100
1 Threshold	271A MSES25SS		PE	087100
1 Gasketing	S88D		PE	087100
1 Rain Guard	346C x LAR		PE	087100
2 Sweep	315CN		PE	087100
1 Astragal	S772D [mtg on mull]		PE	087100

Notes: Hardware listed for design criteria, confirm with specific door manufacturer the hardware requirements to meet specified windstorm rating - Provide 3rd party test results for confirmation.

Set: 7.0

Doors: [D115A](#)

Description: EXT ELEC

3 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK	087100
1 Rim Exit Device, Nightlatch	ED5200 PR957ET M107	630	RU	087100
1 Cylinder	As required	626	RU	087100
1 Surface Closer	DC8210 A11	689	RU	087100
1 Threshold	271A MSES25SS		PE	087100
1 Gasketing	S88D		PE	087100
1 Rain Guard	346C x LAR		PE	087100
1 Sweep	3452AV		PE	087100

Notes: Hardware listed for design criteria, confirm with specific door manufacturer the hardware requirements to meet specified windstorm rating - Provide 3rd party test results for confirmation.

Set: 8.0

Doors: [D134B](#), [D135A](#)

Description: EXT LAB

3 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK	087100
1 Rim Exit Device, Classroom	ED5200 PR955ET M107	630	RU	087100
1 Cylinder	As required	626	RU	087100
1 Surface Closer	DC8210 A11	689	RU	087100
1 Kick Plate	K1050 10" X 2" LDW	US32D	RO	087100
1 Threshold	271A MSES25SS		PE	087100
1 Gasketing	303AS		PE	087100
1 Rain Guard	346C x LAR		PE	087100
1 Sweep	3452AV		PE	087100

Set: 9.0

Doors: [D131A](#)

Description: EXT SHIP / RECV

4 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK	087100
1 Dormitory Lock	ML2065 PSA	626	RU	087100

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1 Surface Closer	DC8210 A11	689	RU	087100
1 Armor Plate	K1050 36" X 2" LDW	US32D	RO	087100
1 Threshold	271A MSES25SS		PE	087100
1 Gasketing	S88D		PE	087100
1 Rain Guard	346C x LAR		PE	087100
1 Sweep	3452AV		PE	087100
1 Position Switch	DPS-M/W-WH (as required)		SU	087100 ⚡

Notes: Hardware listed for design criteria, confirm with specific door manufacturer the hardware requirements to meet specified windstorm rating - Provide 3rd party test results for confirmation.

Set: 10.0

Doors: DS3002-1

Description: EXT LAB

3 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK	087100
1 Security Storeroom Lock	ML2059 PSA	626	RU	087100
1 Surface Closer	DC8210 A11	689	RU	087100
1 Kick Plate	K1050 10" X 2" LDW	US32D	RO	087100
1 Threshold	271A MSES25SS		PE	087100
1 Gasketing	S88D		PE	087100
1 Rain Guard [Head]	347A X 68AR		PE	087100
1 Gasketing	312CR		PE	087100
1 FL Roof gasket system	Pemko-FLR1		PE	
1 Sweep	3452AV		PE	087100
2 Astragal [Head & Sill]	S771D X LAR		PE	087100

Set: 11.0

Doors: D100A, D100E, D200A, D200D

Description: CORR PR - RATED - EAC

7 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK	087100
1 Hinge (heavy weight-Elec)	T4A3786 QCXX 4-1/2" x 4-1/2"	US26D	MK	087100 ⚡
1 Fire Rated Surf Vert Rod, Exit Only	ED5470B EO M55	630	RU	087100
1 Fire Rated Surf Vert Rod, Nightlatch	ED5470B PR957ET M55 M92 MELR	630	RU	087100 ⚡
2 Surface Closer	DC8200 / 8210	689	RU	087100
2 Kick Plate	K1050 10" X 2" LDW	US32D	RO	087100

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2 Door Stop	409 / 446 as required	US26D RO 087100
1 ElectroLynx Harness	QC-C1500 [PS to hinge]	MK 087100 ⚡
1 ElectroLynx Harness	QC-CXXP [Lock / exit to hinge]	MK 087100 ⚡
1 Card Reader	SE RP40 / SE RP15 as req	087100 ⚡
2 Position Switch	DPS-M/W-WH (as required)	SU 087100 ⚡
1 Power Supply	AQLX-E1 - Size as required	SU 087100 ⚡

Notes: Door normally closed and secured.
Authorized credential retracts the latchbolt to allow free entry, door relocks upon closing. REX (request to exit) switch in device rail allow for free exit at all times
Entry by key override at all times
Door is fail secure

Set: 12.0

Doors: D120, D125, D127, **D134**, D230, D232

Description: LAB UN-EQ PR - EAC

7 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D MK 087100
1 Hinge, Full Mortise [Elec]	TA2714 QCXX 4-1/2" x 4-1/2"	US26D MK 087100 ⚡
1 Dust Proof Strike	570	US26D RO 087100
1 Flush Bolt (Self-latching)	2845 / 2945 (as required)	US26D RO 087100
1 Fire Rated Mortise Exit, Classroom	ED5600AL PR9M55ET M92 MELR	630 RU 087100 ⚡
1 Cylinder	As required	626 RU 087100
2 Surface Closer	DC8200 / 8210	689 RU 087100
1 ElectroLynx Harness	QC-C1500 [PS to hinge]	MK 087100 ⚡
1 ElectroLynx Harness	QC-CXXP [Lock / exit to hinge]	MK 087100 ⚡
1 Card Reader	SE RP40 / SE RP15 as req	087100 ⚡
2 Position Switch	DPS-M/W-WH (as required)	SU 087100 ⚡
1 Power Supply	AQLX-E1 - Size as required	SU 087100 ⚡

Notes: Presenting a valid credential releases the lever to allow free entry, door relocks upon closing. REX (request to exit) switch in the lock allow for free exit at all times
Entry by key override at all times
Door is fail secure

Set: 13.0

Doors: D131, D135

Description: SHIP / RECV PR - RATED

8 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D MK 087100
1 Dust Proof Strike	570	US26D RO 087100
1 Flush Bolt (Self-latching)	2845 / 2945 (as required)	US26D RO 087100
1 Classroom Lock	CL3355 PZD	626 RU 087100
1 Coordinator (W/mtg plates)	2672 x Mtg Brkts	Black RO 087100
2 Surface Closer	DC8200 / 8210	689 RU 087100
2 Armor Plate	K1050 36" X 2" LDW	US32D RO 087100
2 Door Stop	409 / 446 as required	US26D RO 087100
1 Gasketing	S88D	PE 087100
1 Astragal	357SP X S88D	PE 087100

Set: 14.0

Doors: D110, D111, D126, D128, D208, D214, D215, D225, D231, D233

Description: LAB PR -EAC

7 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D MK 087100
1 Hinge, Full Mortise [Elec]	TA2714 QCXX 4-1/2" x 4-1/2"	US26D MK 087100 ⚡
1 Dust Proof Strike	570	US26D RO 087100
1 Flush Bolt (Self-latching)	2845 / 2945 (as required)	US26D RO 087100
1 Mortise Exit Device, Classroom	ED5600L PR9M55ET M92 MELR	630 RU 087100 ⚡
1 Cylinder	As required	626 RU 087100
1 Coordinator (W/mtg plates)	2672 x Mtg Brkts	Black RO 087100
2 Surface Closer	DC8200 / 8210	689 RU 087100
2 Mop Plate	K1050 4" X 1" LDW	US32D RO 087100
2 Kick Plate	K1050 10" X 2" LDW	US32D RO 087100
2 Door Stop	409 / 446 as required	US26D RO 087100
1 Gasketing	S88D	PE 087100
1 Astragal	357SP X S88D	PE 087100
1 ElectroLynx Harness	QC-C1500 [PS to hinge]	MK 087100 ⚡
1 ElectroLynx Harness	QC-CXXP [Lock / exit to hinge]	MK 087100 ⚡
1 Card Reader	SE RP40 / SE RP15 as req	087100 ⚡
2 Position Switch	DPS-M/W-WH (as required)	SU 087100 ⚡
1 Power Supply	AQLX-E1 - Size as required	SU 087100 ⚡

Set: 15.0

Doors: DS1001-1, DS1002-1, DS2001-1, DS2002-1

Description: STAIR - RATED

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D MK 087100
1 Fire Rated Rim Exit, Passage	ED5200A PR910ET	630 RU 087100
1 Surface Closer	DC8200 / 8210	689 RU 087100
1 Kick Plate	K1050 10" X 2" LDW	US32D RO 087100
1 Door Stop	409 / 446 as required	US26D RO 087100
1 Gasketing	S88D	PE 087100

Set: 16.0

Doors: D121, D123, D226, D228, D234

Description: LAB - RATED - EAC

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D MK 087100
1 Hinge, Full Mortise [Elec]	TA2714 QCXX 4-1/2" x 4-1/2"	US26D MK 087100 ⚡
1 Electrified Lockset	CL33905 PZD M92	626 RU 087100 ⚡
1 Surface Closer	DC8200 / 8210	689 RU 087100
1 Mop Plate	K1050 4" X 1" LDW	US32D RO 087100
1 Kick Plate	K1050 10" X 2" LDW	US32D RO 087100
1 Door Stop	409 / 446 as required	US26D RO 087100
1 Gasketing	S88D	PE 087100
1 ElectroLynx Harness	QC-C1500 [PS to hinge]	MK 087100 ⚡
1 ElectroLynx Harness	QC-CXXP [Lock / exit to hinge]	MK 087100 ⚡
1 Card Reader	SE RP40 / SE RP15 as req	087100 ⚡
1 Position Switch	DPS-M/W-WH (as required)	SU 087100 ⚡
1 Power Supply	AQLX-E1 - Size as required	SU 087100 ⚡

Set: 17.0

Doors: D100F

Description: CORR PR

6 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D MK 087100
1 Surface Vert Rod Exit, Dummy	ED5470 PR950ET M55	630 RU 087100
1 Surface Vert Rod Exit, Classroom	ED5470 PR955ET M55	630 RU 087100
1 Cylinder	As required	626 RU 087100

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2 Surface Closer	DC8200 / 8210	689	RU	087100
2 Kick Plate	K1050 10" X 2" LDW	US32D	RO	087100
2 Door Stop	409 / 446 as required	US26D	RO	087100
2 Silencer	608		RO	087100

Set: 18.0

Doors: D200E
Description: SERV CORR PR

8 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK	087100
2 Flush Bolt	555 [12" / 72" AFF]	US26D	RO	087100
1 Dust Proof Strike	570	US26D	RO	087100
1 Classroom Lock	CL3355 PZD	626	RU	087100
2 Surface Closer	DC8200 / 8210	689	RU	087100
2 Armor Plate	K1050 36" X 2" LDW	US32D	RO	087100
2 Door Stop	409 / 446 as required	US26D	RO	087100
1 Gasketing	S88D		PE	087100
1 Astragal	357SP X S88D		PE	087100

Set: 19.0

Doors: D113, D122, D124, D217, D221, D222, D223, D224, D227, D229, D237, D238
Description: LAB - EAC

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK	087100
1 Hinge, Full Mortise [Elec]	TA2714 QCXX 4-1/2" x 4-1/2"	US26D	MK	087100 ⚡
1 Classroom Lock	CL3355 PZD	626	RU	087100
2 Surface Closer	DC8200 / 8210	689	RU	087100
2 Mop Plate	K1050 4" X 1" LDW	US32D	RO	087100
2 Kick Plate	K1050 10" X 2" LDW	US32D	RO	087100
2 Door Stop	409 / 446 as required	US26D	RO	087100
1 Gasketing	S88D		PE	087100
1 ElectroLynx Harness	QC-C1500 [PS to hinge]		MK	087100 ⚡
1 ElectroLynx Harness	QC-CXXP [Lock / exit to hinge]		MK	087100 ⚡
1 Card Reader	SE RP40 / SE RP15 as req			087100 ⚡
1 Position Switch	DPS-M/W-WH (as required)		SU	087100 ⚡
1 Power Supply	AQLX-E1 - Size as required		SU	087100 ⚡

Set: 20.0

Doors: D115, D116, D220
Description: ELEC

4 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK	087100
1 Rim Exit Device, Nightlatch	ED5200 PR957ET M107	630	RU	087100
1 Cylinder	As required	626	RU	087100
1 Surface Closer	DC8200 / 8210	689	RU	087100
1 Door Stop	409 / 446 as required	US26D	RO	087100
3 Silencer	608		RO	087100

Set: 21.0

Doors: D119
Description: MEP

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK	087100
1 Classroom Lock	CL3355 PZD	626	RU	087100
1 Surface Closer	DC8200 / 8210	689	RU	087100
1 Kick Plate	K1050 10" X 2" LDW	US32D	RO	087100
1 Door Stop	409 / 446 as required	US26D	RO	087100
3 Silencer	608		RO	087100

Set: 22.0

Doors: D202
Description: JANITOR

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK	087100
1 Classroom Lock	CL3355 PZD	626	RU	087100
1 Surface Closer	DC8200 / 8210	689	RU	087100
1 Mop Plate	K1050 4" X 1" LDW	US32D	RO	087100
1 Kick Plate	K1050 10" X 2" LDW	US32D	RO	087100
1 Door Stop	409 / 446 as required	US26D	RO	087100
1 Gasketing	S88D		PE	087100

Set: 23.0

Doors: D110B, D111B, D120B, D121A, D122A, D123A, D124A, D125B, D126B, D127B, D128B, D203A, D203B, D207, D209, D209B, D210A, D214B, D215B, D225B, D226B, D230B, D231B, D232B, D233B, D238B

Description: LAB / LAB

4 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D MK 087100
1 Institution Lock	CL3332 PZD	626 RU 087100
1 Surface Closer	DC8200 / 8210	689 RU 087100
1 Mop Plate	K1050 4" X 1" LDW	US32D RO 087100
1 Kick Plate	K1050 10" X 2" LDW	US32D RO 087100
1 Door Stop	409 / 446 as required	US26D RO 087100
1 Gasketing	S88D	PE 087100

Set: 24.0

Doors: [D134A](#)

Description: SHOP

4 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D MK 087100
1 Classroom Lock	CL3355 PZD	626 RU 087100
1 Surface Closer	DC8200 / 8210	689 RU 087100
1 Armor Plate	K1050 36" X 2" LDW	US32D RO 087100
1 Door Stop	409 / 446 as required	US26D RO 087100
1 Gasketing	S88D	PE 087100

Set: 25.0

Doors: D236A

Description: BREAK

4 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D MK 087100
1 Passage Latch	CL3310 PZD	626 RU 087100
1 Surface Closer	DC8200 / 8210	689 RU 087100
1 Mop Plate	K1050 4" X 1" LDW	US32D RO 087100
1 Kick Plate	K1050 10" X 2" LDW	US32D RO 087100
1 Door Stop	409 / 446 as required	US26D RO 087100
1 Gasketing	S88D	PE 087100

Set: 26.0

Doors: D108, D130, D212, D235
Description: RESTROOM

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D MK 087100
1 Pull Plate	BF 110 x 70C	US32D RO 087100
1 Push Plate	70C	US32D RO 087100
1 Surface Closer	DC8200 / 8210	689 RU 087100
1 Mop Plate	K1050 4" X 1" LDW	US32D RO 087100
1 Kick Plate	K1050 10" X 2" LDW	US32D RO 087100
1 Door Stop	409 / 446 as required	US26D RO 087100
1 Gasketing	S88D	PE 087100

Set: 27.0

Doors: D100B, D103A, D103B, D106, D109B, D109C, D109D, D109E, D112B, D112C, D112D, D112E, D114B, D114C, D114D, D114E, D213B, D213C, D213D, D213E, D216B, D216C, D216D, D216E, D219B, D219C, D219D, D219E
Description: OFFICE / MULTIPURPOSE - ALUM

1 Continuous Hinge	CFMXXHD1	PE 087100
2 Door Pull	BF168	US32D RO 087100
1 Concealed Closer	91N / PH91 - 90N [special template]	626 RF 087100
1 Door Stop	409 / 446 as required	US26D RO 087100
1 Gasketing	by door / frame mfg	

Notes: Hardware listed for design purposes -

Set: 28.0

Doors: D101, D102, D107, D129A, D129B, D201, D204, D206
Description: CONF / BREAK - ALUM

1 Continuous Hinge	CFMXXHD1	PE 087100
1 Roller Latch	592	US26D RO 087100
2 Door Pull	BF168	US32D RO 087100
1 Door Stop	409 / 446 as required	US26D RO 087100
1 Gasketing	by door / frame mfg	

Notes: Hardware listed for design purposes -

Set: 29.0

Doors: D101A, D109A, D110A, D111A, D112A, D113A, D114A, D117, D117A, D120A, D125A, D126A, D127A, D128A, D132, D202A, D207A, D208A, D209A, D210, D213A, D214A, D215A, D216A, D217A, D218, D219A, D221A, D222A, D223A, D224A, D225A, D226A, D227A, D228A, D229A, D230A, D231A, D232A, D233A, D234A, D237A, D238A

Description: STOR

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D MK 087100
1 Classroom Lock	CL3355 PZD	626 RU 087100
1 Door Stop	409 / 446 as required	US26D RO 087100
3 Silencer	608	RO 087100

Set: 30.0

Doors: D133, D205

Description: JAN

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D MK 087100
1 Classroom Lock	CL3355 PZD	626 RU 087100
1 Mop Plate	K1050 4" X 1" LDW	US32D RO 087100
1 Door Stop	409 / 446 as required	US26D RO 087100
1 Gasketing	S88D	PE 087100

Set: 31.0

Doors: D105

Description: OFFICE

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D MK 087100
1 Entrance Lock	CL3351 PZD	626 RU 087100
1 Door Stop	409 / 446 as required	US26D RO 087100
3 Silencer	608	RO 087100

Set: 32.0

Doors: D118
Description: TOILET

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D MK 087100
1 Privacy Lock	CL3320 PZD	626 RU 087100
1 Mop Plate	K1050 4" X 1" LDW	US32D RO 087100
1 Door Stop	409 / 446 as required	US26D RO 087100
1 Gasketing	S88D	PE 087100

Set: 33.0

Doors: D211
Description: PRINT

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D MK 087100
1 Passage Latch	CL3310 PZD	626 RU 087100
1 Door Stop	409 / 446 as required	US26D RO 087100
3 Silencer	608	RO 087100

Set: 34.0

Doors: D131B, D134C, D135B
Description: OHD

1 HBO All hardware By door mfg

END OF SECTION 087100

SECTION 088000 GLAZING

SPECIFYING STRATEGY

1.01 HOW TO USE THIS SECTION

- A. The most important step is the selection of companion narrow scope sections which contain the bulk of Part 2 content relevant to specific glazing product type.
- B. Part 3 of this section is intended to function as a single location for "glazing methods" applicable to any number of glazing products. Therefore, installation accessories have been retained in this section. The other sections in this group have their installation methods linked to this section.
- C. Edit the "Installation - Glazing Methods" list in Part 3 to correspond with types of openings and applications in the project. Glazing methods differ based on application, framing, and location (exterior or interior). Type of glazing material is a less critical criterion for selection of optimal glazing method.

PART 1 GENERAL

2.01 SECTION INCLUDES

- A. Insulating glass units.
- B. Glazing units, monolithic.
- C. Glazing compounds.

2.02 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials Current Edition.
- B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test 2015.
- C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- D. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers 2005 (Reapproved 2019).
- E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
- F. ASTM C1036 - Standard Specification for Flat Glass 2021.
- G. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass 2018.
- H. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass 2019.
- I. ASTM C1193 - Standard Guide for Use of Joint Sealants 2016.
- J. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass 2021.
- K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- L. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings 2016.
- M. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation 2010.
- N. GANA (SM) - GANA Sealant Manual 2008.
- O. ICC (IBC) - International Building Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- P. IGMA TM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use 1990 (2016).
- Q. ITS (DIR) - Directory of Listed Products current edition.

- R. NFRC 100 - Procedure for Determining Fenestration Product U-factors 2017.
- S. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence 2014, with Errata (2017).
- T. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems 2017.
- U. UL (DIR) - Online Certifications Directory Current Edition.

2.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data on Insulating Glass Unit, Glazing Unit, Plastic Sheet Glazing Unit, Plastic Film, and [] Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- D. Samples: Submit two samples 8 by [] inch in size of glass units.
- E. Certificate: Certify that products of this section meet or exceed specified requirements.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.
- H. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

2.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least 10 years documented experience.

2.05 MOCK-UPS

- A. Provide on-site glazing mock-up with the specified glazing components.
- B. Locate where directed.

2.06 FIELD CONDITIONS

- A. Do not install glazing when ambient temperature is less than 40 degrees F.
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

2.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Insulating Glass Units: Provide a ten (10) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.
- C. Laminated Glass: Provide a ten (10) year manufacturer warranty to include coverage for delamination, including providing products to replace failed units.
- D. Polycarbonate Sheet Glazing: Provide a ten (10) year manufacturer warranty to include coverage for breakage, coating failure, abrasion resistance, including providing products to replace failed units.
- E. Heat Soaked Tempered Glass: Provide a ten (10) year manufacturer warranty to include coverage for spontaneous breakage of fully tempered glass caused by nickel sulfide (NiS) inclusions.

PART 2 PRODUCTS

3.01 MANUFACTURERS

- A. Float Glass Manufacturers:
 - 1. AGC Glass North America, Inc; [____]: www.agcglass.com/#sle.
 - 2. Cardinal Glass Industries; [____]: www.cardinalcorp.com/#sle.
 - 3. Pilkington North America Inc; [____]: www.pilkington.com/na/#sle.
 - 4. Vitro Architectural Glass (formerly PPG Glass); [____]: www.vitroglazings.com/#sle.
- B. Laminated Glass Manufacturers:
 - 1. Cardinal Glass Industries; [____]: www.cardinalcorp.com/#sle.
 - 2. Viracon, Architectural Glass segment of Apogee Enterprises, Inc; [____]: www.viracon.com/#sle.
- C. Fire-Resistance-Rated Glass: Provide products as required to achieve indicated fire-rating period.
 - 1. SAFTIFIRST, a division of O'Keeffe's Inc; SuperLite II-XL: www.safti.com/#sle.
 - 2. Technical Glass Products; Pilkington Pyrostop: www.fireglass.com/#sle.

3.02 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

- A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
 - 1. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 - 2. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
 - 3. Glass thicknesses listed are minimum.
- B. Weather-Resistive Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure water-resistive barrier, vapor retarder, and/or air barrier.
 - 1. In conjunction with weather barrier related materials described in other sections, as follows:
- C. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
 - 1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 - 2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 - 3. Solar Optical Properties: Comply with NFRC 300 test method.

3.03 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless otherwise indicated.
 - 1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.
 - 2. Kind FT - Fully Tempered Type: Complies with ASTM C1048.
 - 3. Heat-Soak Testing (HST): Provide HST of fully tempered glass used on high-risk or other demanding applications of project, to reduce risks of spontaneous breakage due to nickel sulfide (NiS) induced fractures in accordance with industry established testing requirements.
- B. Laminated Glass: Float glass laminated in accordance with ASTM C1172.
 - 1. Laminated Safety Glass: Complies with ANSI Z97.1 - Class B or 16 CFR 1201 - Category I impact test requirements.

3.04 BASIS OF DESIGN - INSULATING GLASS UNITS

- A. Basis of Design - Insulating Glass Units: Vision glazing, with low-e coating.
 - 1. Applications: Exterior insulating glass glazing unless otherwise indicated.
 - 2. Space between lites filled with air.
 - 3. Total Thickness: 1 inch.
 - 4. Thermal Transmittance (U-Value), Winter - Center of Glass: 0.29, nominal.

5. Visible Light Transmittance (VLT): 64 percent, nominal.
6. Solar Heat Gain Coefficient (SHGC): 0.27, nominal.
7. Visible Light Reflectance, Outside: 12 percent, nominal.
8. Durability: Certified by an independent testing agency to comply with ASTM E2190.
9. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
10. Metal Edge Spacers: Aluminum, manufacturer's standard corners.
11. Spacer Color: Black.
12. Edge Seal:
 - a. Dual-Sealed System: Provide polyisobutylene sealant as primary seal applied between spacer and glass panes, and silicone or polyurethane sealant as secondary seal applied around perimeter.
13. Color: Black.
14. Purge interpane space with argon gas, hermetically sealed.
15. 1" Insulated Glass
 - a. Basis of Design - Solar Ban 90 (2) Acuity Glass by Vitro Architectural Glass: www.vitroglazings.com/#sle.
img {max-width:300px;max-height:300px;width:225px;height:225px;}span {white-space:pre; }.del { color: red;text-decoration: line-through; }.ins { color: red;text-decoration: underline; }.ch-d { color: red;text-decoration: line-through; }.ch-i { color: red;text-decoration:underline; }.prev-text { color: red ;text-decoration:line-through ;}.ch-t { color:red;text-decoration:underline ;} .del.user span[choice-type] { color: red !important;text-decoration: line-through;}.del.user span[text-type] { color: red !important;text-decoration: line-through;}.del.user span.multi-option-choice span[text-type='UnitOfMeasure'] .UOMFillEnglish { color: red !important;text-decoration: line-through;}.del.user span.multi-option-choice span[text-type='UnitOfMeasure'] .UOMFillMetric { color: red !important;text-decoration: line-through;}.ins.master span[choice-type] { color: red !important;text-decoration: underline;}.ins.master span[text-type] { color: red !important;text-decoration: underline;}.ins.master span.multi-option-choice span[text-type='UnitOfMeasure'] .UOMFillEnglish { color: red !important;text-decoration: underline;}.ins.master span.multi-option-choice span[text-type='UnitOfMeasure'] .UOMFillMetric { color: red !important;text-decoration: underline;}.GTeditTC span.del { color:red; text-decoration:line-through;}.GTeditTC span { color:red; text-decoration:underline;}</style>
 - 1) Low-E Coating: Solarban 90 Solar Control sputter coated on second surface.
 - 2) Glass: Clear.
16. 1" Insulated /Tempered Glass
17. Basis of Design - Solar Ban 90 (2) Acuity Glass by Vitro Architectural Glass: www.vitroglazings.com/#sle.

weight: 400; letter-spacing: normal; orphans: 2; text-align: left; text-indent: 0px; text-transform: none; white-space: pre-wrap; widows: 2; word-spacing: 0px; -webkit-text-stroke-width: 0px; background-color: rgb(242, 242, 242); text-decoration-thickness: initial; text-decoration-style: initial; text-decoration-color: initial; display: inline !important; float: none;">Basis of Design - Solar Ban 90 (2)

Acuity Glass by Vitro Architectural Glass:

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www.vitroglazings.com/#sle.</span><style>* {font-family:"Arial";font-size:10pt;}img {max-width:300px;max-height:300px;width:225px;height:225px;}span {white-space:pre; }.del { color: red;text-decoration: line-through; }.ins { color: red;text-decoration: underline; }.ch-d { color: red;text-decoration: line-through; }.ch-i { color: red;text-decoration:underline; }.prev-text { color: red;text-decoration:line-through; }.ch-t { color:red;text-decoration:underline; }.del.user span[choice-type] { color: red !important;text-decoration: line-through; }.del.user span[text-type] { color: red !important;text-decoration: line-through; }.del.user span.multi-option-choice span[text-type='UnitOfMeasure'] .UOMFillEnglish { color: red !important;text-decoration: line-through; }.del.user span.multi-option-choice span[text-type='UnitOfMeasure'] .UOMFillMetric { color: red !important;text-decoration: line-through; }.ins.master span[choice-type] { color: red !important;text-decoration: underline; }.ins.master span[text-type] { color: red !important;text-decoration: underline; }.ins.master span.multi-option-choice span[text-type='UnitOfMeasure'] .UOMFillEnglish { color: red !important;text-decoration: underline; }.ins.master span.multi-option-choice span[text-type='UnitOfMeasure'] .UOMFillMetric { color: red !important;text-decoration: underline; }.GTEditTC span.del { color:red; text-decoration:line-through; }.GTEditTC span { color:red; text-decoration:underline; }</style>
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- a. Outboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
 - 1) Low-E Coating: Solarban 90 Solar Control sputter coated on second surface..
 - 2) Glass: Clear.
 - 3) Glass Tint: [_____].
- b. Inboard Lite: Fully tempered float glass, 1/4 inch thick.
 - 1) Coating: No coating on inboard lite.

3.05 GLAZING UNITS

- A. Monolithic Exterior Vision Glazing:
 1. Applications: As scheduled.
 2. Glass Type: Heat-strengthened float glass.
 3. Tint: Clear.
 4. Thickness: 1/4 inch, nominal.
- B. Monolithic Interior Vision Glazing:
 1. Applications: As scheduled.
 2. Glass Type: Annealed float glass.
 3. Tint: Clear.
 4. Thickness: 1/4 inch, nominal.
- C. Monolithic and Tempered Interior Vision Glazing
 1. Applications: As scheduled.
 2. Glass Type: Fully tempered float glass
 3. Tint: Clear.
 4. Thickness: 1/4 inch, nominal.

- D. Fire-Resistance-Rated Glazing: Type, thickness, and configuration of glazing that contains flame, smoke, and blocks radiant heat, as required to achieve indicated fire-rating period exceeding 45 minutes.
1. Applications:
 - a. Glazing in fire-rated door assembly.
 - b. Glazing in fire-rated window assembly.
 - c. Glazing in sidelites, borrowed lites, and other glazed openings in fire-rated wall assemblies.
 2. Glass Type: Multi-laminate annealed glass with intumescent fire retardant interlayers.
 3. Provide products listed by ITS (DIR) or UL (DIR) and approved by authorities having jurisdiction.
 4. Safety Glazing Certification: 16 CFR 1201 Category II.
 5. Glazing Method: As required for fire rating.
 6. Fire-Rating Period: 60 minutes.
 7. Markings for Fire-Resistance-Rated Glazing Assemblies: Provide permanent markings on fire-resistance-rated glazing in compliance with ICC (IBC), local building code, and authorities having jurisdiction.
 - a. "W" - meets wall assembly criteria of ASTM E119 or UL 263 fire test standards.
 - b. "D" - meets fire door assembly criteria of NFPA 252, UL 10B, or UL 10C fire test standards.
 - c. "H" - meets fire door assembly hose stream test of NFPA 252, UL 10B, or UL 10C fire test standards.
 - d. "T" - meets temperature rise of not more than 450 degrees F above ambient at end of 30 minutes fire exposure in accordance with NFPA 252, UL 10B, or UL 10C fire test standards.
 - e. "XXX" - placeholder that represents fire-rating period, in minutes.
- E. Fire-Protection-Rated Glazing: Type, thickness, and configuration of glazing that contains flame, smoke, and does not block radiant heat, as required to achieve fire-doors indicated fire-rating period of 90 minutes or less.
1. Applications:
 - a. Glazing in fire-rated door assembly.
 - b. Glazing in fire-rated window assembly.
 - c. Other locations as indicated on drawings.
 2. Glass Type: Safety ceramic glass.
 3. Provide products listed by ITS (DIR) or UL (DIR) and approved by authorities having jurisdiction.
 4. Safety Glazing Certification: 16 CFR 1201 Category II.
 5. Glazing Method: As required for fire rating.
 6. Fire-Rating Period: As indicated on drawings.
 7. Markings for Fire-Protection-Rated Glazing Assemblies: Provide permanent markings on fire-protection-rated glazing in compliance with ICC (IBC), local building code, and authorities having jurisdiction
 - a. "D" - meets fire door assembly criteria of NFPA 252, UL 10B, or UL 10C fire test standards.
 - b. "OH" - meets fire window assembly criteria including hose stream test of NFPA 257, or UL 9 fire test standards.
 - c. "H" - meets fire door assembly hose stream test of NFPA 252, UL 10B, or UL 10C fire tests standards.
 - d. "XXX" - placeholder that represents fire-rating period, in minutes.
- F. Security Glazing: Laminated glass, 2-Ply.
1. Applications: Locations as indicated on drawings.
 2. Tint: Clear.
 3. Thickness: 9/16 inch.
 4. Outer Lite: Heat-strengthened glass.

5. Interlayer: Polyvinyl butyral (PVB), thickness as required to meet performance criteria.
6. Inside Lite: Heat-strengthened glass.

3.06 GLAZING COMPOUNDS

- A. Butyl Sealant: Single component; ASTM C920 Grade NS, Class 12-1/2, Uses M and A, Shore A hardness of 10 to 20; black color.
- B. Type GC-5 - Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; non-bleeding, non-staining; ASTM C920 Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; [] color.

3.07 ACCESSORIES

- A. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch by width of glazing rabbet space minus 1/16 inch by height to suit glazing method and pane weight and area.
- B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Minimum 3 inch long by one half the height of the glazing stop by thickness to suit application, self adhesive on one face.
- C. Glazing Tape, Back Bedding Mastic Type: Preformed, butyl-based, 100 percent solids compound with integral resilient spacer rod applicable to application indicated; 5 to 30 cured Shore A durometer hardness; coiled on release paper; black color.
- D. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.
- E. Glazing Clips: Manufacturer's standard type.

PART 3 EXECUTION

4.01 VERIFICATION OF CONDITIONS

- A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.
- C. Verify that sealing between joints of glass framing members has been completed effectively.
- D. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

4.02 PREPARATION

- A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

4.03 INSTALLATION, GENERAL

- A. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.
- B. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.
- C. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.
- D. Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.
- E. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.

- F. Prevent glass from contact with any contaminating substances that may be the result of construction operations such as, and not limited to the following; weld splatter, fire-safing, plastering, mortar droppings, etc.

4.04 FIELD QUALITY CONTROL

- A. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.
- B. Monitor and report installation procedures and unacceptable conditions.

4.05 CLEANING

- A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- B. Remove nonpermanent labels immediately after glazing installation is complete.
- C. Clean glass and adjacent surfaces after sealants are fully cured.
- D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

4.06 PROTECTION

- A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.
- B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION 088000

**SECTION 088300
MIRRORS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Glass mirrors.
 - 1. Annealed float glass.

1.02 REFERENCE STANDARDS

- A. ASTM C1036 - Standard Specification for Flat Glass 2021.
- B. ASTM C1193 - Standard Guide for Use of Joint Sealants 2016.
- C. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror 2018.
- D. GANA (TIPS) - Mirrors: Handle with Extreme Care (Tips for the Professional on the Care and Handling of Mirrors) 2011.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data on Mirror Types: Submit structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C. Manufacturer's Certificate: Certify that mirrors, meets or exceeds specified requirements.
- D. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Mirror Glazing: One of each type and size.

1.04 QUALITY ASSURANCE

- A. Fabricate, store, transport, receive, install, and clean mirrors in accordance with recommendations of GANA (TIPS).

1.05 FIELD CONDITIONS

- A. Do not install mirrors when ambient temperature is less than 50 degrees F.
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.06 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for reflective coating on mirrors and replacement of same.

PART 2 PRODUCTS

2.01 MANUFACTURERS

2.02 MATERIALS

- A. Mirror Design Criteria: Select materials and/or provide supports as required to limit mirror material deflection to 1/200, or to the flexure limit of glass, with full recovery of glazing materials, whichever is less.
- B. Mirror Glass: Clear, annealed float glass; ASTM C1036, with copper and silver coatings, and protective overcoating.
 - 1. Thickness: 1/4 inch.
 - 2. Size: As noted on drawings.

2.03 ACCESSORIES

- A. Mirror Attachment Accessories: Stainless steel clips.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that openings for mirrored glazing are correctly sized and within tolerance.
- B. Verify that surfaces of mirror frames or recesses are clean, free of obstructions, and ready for installation of mirrors.

3.02 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous mirror frames or recesses with substrate compatible primer or sealer. Prime surfaces scheduled to receive sealant.
- C. Prepare installation in accordance with ASTM C1193 for solvent release sealants, and install sealant in accordance with manufacturer's instructions.

3.03 INSTALLATION

- A. Install mirrors in accordance with GANA (TIPS) and manufacturers recommendations.
- B. Set mirrors plumb and level, and free of optical distortion.
- C. Set mirrors with edge clearance free of surrounding construction including countertops or backsplashes.
- D. Frameless Mirrors: Set mirrors with clips, and anchor rigidly to wall construction.

3.04 CLEANING

- A. Remove labels after work is complete.
- B. Clean mirrors and adjacent surfaces.

END OF SECTION 088300

**SECTION 092116
GYPSUM BOARD ASSEMBLIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Metal stud wall framing.
- C. Metal channel ceiling framing.
- D. Acoustic insulation.
- E. Gypsum sheathing.
- F. Cementitious backing board.
- G. Gypsum wallboard.
- H. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Wood blocking product and execution requirements.

1.03 REFERENCE STANDARDS

- A. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members 2012.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- D. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members 2015.
- E. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board 2017.
- F. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members 2018.
- G. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing 2017.
- H. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products 2020.
- I. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board 2020.
- J. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness 2018.
- K. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs 2020.
- L. ASTM C1047 - Standard Specification for Accessories For Gypsum Wallboard and Gypsum Veneer Base 2019.
- M. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing 2017.
- N. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel 2018.
- O. ASTM C1396/C1396M - Standard Specification for Gypsum Board 2017.
- P. ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels 2019.

- Q. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber 2016.
- R. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements 2009 (Reapproved 2016).
- S. ASTM E413 - Classification for Rating Sound Insulation 2016.
- T. GA-216 - Application and Finishing of Gypsum Panel Products 2018.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.
- C. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing gypsum board installation and finishing, with minimum 5 years of experience.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
- B. Interior Partitions: Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- C. Fire Rated Assemblies: Provide completed assemblies as indicated on drawings.
 - 1. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).

2.02 METAL FRAMING MATERIALS

- A. Manufacturers - Metal Framing, Connectors, and Accessories:
 - 1. Clarkwestern Dietrich Building Systems LLC: www.clarkdietrich.com.
 - 2. Marino: www.marinoware.com.
 - 3. Phillips Manufacturing Company: www.phillipsmfg.com.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf.
 - 1. Studs: "C" shaped with flat or formed webs with knurled faces.
 - 2. Runners: U shaped, sized to match studs.
 - 3. Ceiling Channels: C-shaped, Slotted when connected to deflection - prime structure above.
 - 4. Furring: Hat-shaped sections, minimum depth of 7/8 inch.
 - 5. Resilient Furring Channels: 1/2 inch depth, for attachment to substrate through both legs; both legs expanded metal mesh.
 - a. Products:
 - 1) Same manufacturer as other framing materials.
 - 2) Substitutions: See Section 016000 - Product Requirements.
- C. Shaft Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 and specified performance requirements.
 - 1. Products:
 - a. Same manufacturer as other framing materials.
- D. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.

- E. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.
 - 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100-12.
 - 2. Material: ASTM A653/A653M steel sheet, SS Grade 50/340, with G60/Z180 hot dipped galvanized coating.
 - 3. Provide components UL-listed for use in UL-listed fire-rated head of partition joint systems indicated on drawings.
 - 4. Deflection and Firestop Track:
 - a. Provide mechanical anchorage devices as described above that accommodate deflection while maintaining the fire-rating of the wall assembly.
 - b. Products:
 - 1) FireTrak Corporation; Posi Klip.
 - 2) Metal-Lite, Inc; The System.
- F. Preformed Top Track Firestop Seal:
 - 1. Provide components UL-listed for use in UL-listed fire-rated head of partition joint systems indicated on drawings.
 - 2. Products:
 - a. Hilti, Inc; Top Track Seal CFS TTS: www.us.hilti.com/#sle.
- G. Non-Loadbearing Framing Accessories:
 - 1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
 - 2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.
 - a. Materials: ASTM A36/A36M formed sheet steel support member with factory-welded ASTM A1003/A1003M steel plate base.
 - 3. Framing Connectors: ASTM A653/A653M G90 galvanized steel clips; secures cold rolled channel to wall studs for lateral bracing.

2.03 BOARD MATERIALS

- A. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 - 2. At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 - 3. Thickness:
 - a. Vertical Surfaces: 1/2 inch.
 - b. Ceilings: 5/8 inch.
 - c. Multi-Layer Assemblies: Thicknesses as indicated on drawings.
 - 4. Paper-Faced Products:
 - a. American Gypsum Company; LightRoc Gypsum Wallboard.
 - b. American Gypsum Company; FireBloc Type X Gypsum Wallboard.
 - c. Georgia-Pacific Gypsum; ToughRock.
 - d. Georgia-Pacific Gypsum; ToughRock Fireguard X.
 - e. Substitutions: See Section 016000 - Product Requirements.
- B. Impact Resistant Wallboard:
 - 1. Application: High-traffic areas indicated.
 - 2. Surface Abrasion: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
 - 3. Indentation: Level 2, minimum, when tested in accordance with ASTM C1629/C1629M.
 - 4. Hard Body Impact: Level 2, minimum, when tested in accordance with ASTM C1629/C1629M.
 - 5. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 6. Type: Fire resistance rated Type X, UL or WH listed.

7. Thickness: 5/8 inch.
 8. Edges: Tapered.
- C. Backing Board For Wet Areas: One of the following products:
1. Application: Surfaces behind tile in wet areas including tub and shower surrounds.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 3. Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.
 - a. Regular Type: Thickness 1/2 inch.
 - b. Fire Resistant Type: Type X core, thickness 5/8 inch.
 - c. Products:
 - 1) Georgia-Pacific Gypsum; DensShield Tile Backer.
 - 2) National Gypsum Company; Gold Bond eXP Tile Backer.
- D. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
1. Application: Ceilings, unless otherwise indicated.
 2. Thickness: 1/2 inch.
 3. Edges: Tapered.
- E. Acoustical Sound Dampening Wall and Ceiling Board: Two layers of heavy paper faced, high density gypsum board separated by a viscoelastic polymer layer and capable of achieving STC rating of 50 or more in typical stud wall assemblies as calculated in accordance with ASTM E413 and when tested in accordance with ASTM E90.
1. Thickness: 5/8 inch.
 2. Long Edges: Tapered.
 3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
- F. Exterior Sheathing Board: Sizes to minimize joints in place; ends square cut.
1. Application: Exterior sheathing, unless otherwise indicated.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 3. Glass Mat Faced Sheathing: Glass mat faced gypsum substrate as defined in ASTM C1177/C1177M.
 4. Core Type: Regular and Type X, as indicated.
 5. Type X Thickness: 5/8 inch.
 6. Regular Board Thickness: 5/8 inch.
 7. Edges: Square.
 8. Glass Mat Faced Products:
 - a. American Gypsum Company; M-Glass Exterior Sheathing Type X.
 - b. American Gypsum Company; M-Glass Exterior Sheathing.
 - c. Georgia-Pacific Gypsum; DensGlass Sheathing.
 - d. Georgia-Pacific Gypsum; DensGlass Fireguard Sheathing.
 - e. Substitutions: See Section 016000 - Product Requirements.
- G. Shaftwall and Coreboard: Type X; 1 inch thick by 24 inches wide, beveled long edges, ends square cut.
1. Paper-Faced Type: Gypsum shaftliner board or gypsum coreboard as defined ASTM C1396/C1396M; water-resistant faces.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 3. Products:
 - a. American Gypsum Company; Shaft Liner.
 - b. Georgia-Pacific Gypsum; ToughRock Shaftliner.
 - c. Substitutions: See Section 016000 - Product Requirements.

2.04 ACCESSORIES

- A. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, unfaced. Thickness: 3 inch.

- B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
 - 1. Products:
 - a. Franklin International, Inc; Titebond GREENchoice Professional Acoustical Smoke and Sound Sealant: www.titebond.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- C. Joint Accessories: ASTM C1047, rigid plastic, galvanized steel, or rolled zinc, unless noted otherwise.
 - 1. Architectural Reveal Beads:
 - a. Shapes: As indicated on drawings.
 - b. Products:
 - 1) Fryreglet; "F" Reveal Model FDM-625-50 and FDM-625-100 : www.fryreglet.com
 - 2. Expansion Joints:
 - a. Type: V-shaped metal with factory-installed protective tape.
- D. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
- E. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inch in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion resistant.
- F. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion resistant.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

3.02 SHAFT WALL INSTALLATION

- A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.

3.03 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.
- B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
 - 1. Level ceiling system to a tolerance of 1/1200.
 - 2. Laterally brace entire suspension system.
 - 3. Install bracing as required at exterior locations to resist wind uplift.
- C. Studs: Space studs as indicated.
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
 - 3. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
- D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- E. Standard Wall Furring: Install at concrete walls scheduled to receive gypsum board, not more than 4 inches from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 16 inches on center.
 - 1. Spacing: As indicated.
- F. Acoustic Furring: Install resilient channels at maximum 24 inches on center. Locate joints over framing members.

- G. Furring for Fire Ratings: Install as required for fire resistance ratings indicated U.L. Assembly requirements..
- H. Blocking: Install wood blocking for support of:
 - 1. Framed openings.
 - 2. Wall mounted cabinets.
 - 3. Plumbing fixtures.
 - 4. Toilet partitions.
 - 5. Toilet accessories.
 - 6. Wall mounted door hardware.

3.04 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Sound Isolation Tape: Apply to vertical studs and top and bottom tracks/runners in accordance with manufacturer's instructions.
- C. Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.05 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Non-Rated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
- C. Double-Layer Non-Rated: Use gypsum board for first layer, placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Use glass mat faced gypsum board at exterior walls and at other locations as indicated. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.
- D. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- E. Exterior Sheathing: Comply with ASTM C1280. Install sheathing vertically, with edges butted tight and ends occurring over firm bearing.
 - 1. Seal joints, cut edges, and holes with water-resistant sealant.
- F. Exterior Soffits: Install exterior soffit board perpendicular to framing, with staggered end joints over framing members or other solid backing.
 - 1. Seal joints, cut edges, and holes with water resistant sealant.

3.06 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
 - 1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.
- D. Decorative Trim: Install at locations shown on drawings and in accordance with manufacturer's instructions.

3.07 JOINT TREATMENT

- A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, embed and finish with setting type joint compound.
- B. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.
- C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 5: Walls and ceilings to receive semi-gloss or gloss paint finish and other areas specifically indicated.

2. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 3. Level 1: Fire rated wall areas above finished ceilings, whether or not accessible in the completed construction.
- D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
1. Feather coats of joint compound so that camber is maximum 1/32 inch.
 2. Taping, filling, and sanding is not required at surfaces behind adhesive applied ceramic tile and fixed cabinetry.
 3. Taping, filling and sanding is not required at base layer of double layer applications.
- E. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.
- F. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

3.08 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION 092116

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**SECTION 092216
NON-STRUCTURAL METAL FRAMING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal partition, ceiling, and soffit framing.
- B. Framing accessories.

1.02 REFERENCE STANDARDS

- A. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members 2012.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- C. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members 2018.
- D. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products 2020.
- E. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs 2020.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data describing framing member materials and finish, product criteria, load charts, and limitations.
- C. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience and approved by manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Framing, Connectors, and Accessories:
 - 1. CEMCO; []: www.cemcosteel.com/#sle.
 - 2. ClarkDietrich Building Systems; []: www.clarkdietrich.com/#sle.
 - 3. Jaimes Industries; []: www.jaimesind.com/#sle.
 - 4. Marino; []: www.marinoware.com/#sle.
 - 5. Simpson Strong Tie; []: www.strongtie.com/#sle.
 - 6. Steel Construction Systems; []: www.steelconsystems.com/#sle.
 - 7. Substitutions: See Section 016000 - Product Requirements.

2.02 FRAMING MATERIALS

- A. Fire Rated Assemblies: Comply with applicable code and as indicated on drawings.
- B. Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.
 - 1. Studs: C shaped with flat or formed webs with knurled faces.
 - 2. Runners: U shaped, sized to match studs.
 - 3. Ceiling Channels: C shaped.
 - 4. Furring: Hat-shaped sections, minimum depth of 7/8 inch.
 - 5. Resilient Furring Channels: Single or double leg configuration; 1/2 inch channel depth.

- C. Loadbearing Studs: As specified in Section 054000.
- D. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
 - 1. Sound Isolation Clips: Molded rubber isolator and steel clip, fastens directly to framing or structure to provide acoustical separation in gypsum board walls and ceilings.
- E. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.
 - 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100-12.
 - 2. Material: ASTM A653/A653M steel sheet, SS Grade 50, with G60/Z180 hot dipped galvanized coating.
 - 3. Provide components UL-listed for use in UL-listed fire-rated head of partition joint systems indicated on drawings.
- F. Deflection and Firestop Track: Intumescent strip factory-applied to track flanges expands when exposed to heat or flames to provide a perimeter joint seal.
- G. Sheet Metal Backing: 0.036 inch thick, galvanized.
- H. Anchorage Devices: Powder actuated.
- I. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, unfaced.
- J. Non-Loadbearing Framing Accessories:
 - 1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
 - 2. Sound Isolation Clips: Molded rubber isolator and steel clip, fastens directly to framing or structure to provide acoustical separation in gypsum board walls and ceilings.
- K. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
- L. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20 Type I - Inorganic.
- M. Sound Isolation Tape: Elastomeric foam tape for sound decoupling.
 - 1. Surface Burning Characteristics: Provide assemblies with flame spread index of 75 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - 2. Tape Thickness: 1/4 inch.
- N. Tracks and Runners: Same material and thickness as studs, bent leg retainer notched to receive studs with provision for crimp locking to stud.
- O. Furring and Bracing Members: Of same material as studs; thickness to suit purpose; complying with applicable requirements of ASTM C754.
- P. Fasteners: ASTM C1002 self-piercing tapping screws.

PART 3 EXECUTION

3.01 INSTALLATION OF STUD FRAMING

- A. Comply with requirements of ASTM C754.
- B. Extend partition framing to structure where indicated and to ceiling in other locations.
- C. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
- D. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
- E. Align and secure top and bottom runners at 24 inches on center.
- F. At partitions indicated with an acoustic rating:

1. Place one bead of acoustic sealant between runners and substrate, studs and adjacent construction.
 2. Sound Isolation Tape: Apply to vertical studs and top and bottom tracks/runners in accordance with manufacturer's instructions.
- G. Fit runners under and above openings; secure intermediate studs to same spacing as wall studs.
- H. Install studs vertically at spacing indicated on drawings.
- I. Align stud web openings horizontally.
- J. Stud splicing is not permissible.
- K. Fabricate corners using a minimum of three studs.
- L. Double stud at wall openings, door and window jambs, not more than 2 inches from each side of openings.
- M. Brace stud framing system rigid.
- N. Coordinate erection of studs with requirements of door frames; install supports and attachments.
- O. Coordinate installation of bucks, anchors, and blocking with electrical, mechanical, and other work to be placed within or behind stud framing.
- P. Blocking: Use wood blocking secured to studs. Provide blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, hardware, and opening frames.
- Q. Sound Isolation Clips: Mechanically attach to framing or structure with fasteners recommended by clip manufacturer. Install at spacing indicated on drawings.
- R. Furring: Coordinate with sound isolation clip spacing and locations. Lap splices a minimum of 6 inches.

3.02 CEILING AND SOFFIT FRAMING

- A. Comply with requirements of ASTM C754.
- B. Install furring after work above ceiling or soffit is complete. Coordinate the location of hangers with other work.
- C. Install furring independent of walls, columns, and above-ceiling work.
- D. Securely anchor hangers to structural members or embed in structural slab. Space hangers as required to limit deflection to criteria indicated. Use rigid hangers at exterior soffits.
- E. Space main carrying channels at maximum 72 inch on center, and not more than 6 inches from wall surfaces. Lap splice securely.
- F. Securely fix carrying channels to hangers to prevent turning or twisting and to transmit full load to hangers.
- G. Place furring channels perpendicular to carrying channels, not more than 2 inches from perimeter walls, and rigidly secure. Lap splices securely.
- H. Reinforce openings in suspension system that interrupt main carrying channels or furring channels with lateral channel bracing. Extend bracing minimum 24 inches past each opening.
- I. Laterally brace suspension system.

3.03 TOLERANCES

- A. Maximum Variation From True Position: 1/8 inch in 10 feet.
- B. Maximum Variation From Plumb: 1/8 inch in 10 feet.

END OF SECTION 092216

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**SECTION 093000
TILING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tile for floor applications.
- B. Tile for wall applications.

1.02 RELATED REQUIREMENTS

- A. Section 092116 - Gypsum Board Assemblies: Tile backer board.

1.03 REFERENCE STANDARDS

- A. ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar 2017.
- B. ANSI A108.1b - American National Standard Specifications for Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar 2017.
- C. ANSI A108.1c - Specifications for Contractors Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Bed with Dry-Set or Latex-Portland Cement 1999 (Reaffirmed 2016).
- D. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile-Setting Epoxy Adhesive 2009 (Revised).
- E. ANSI A108.5 - American National Standard Specifications for Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar 1999 (Reaffirmed 2010).
- F. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy 1999 (Reaffirmed 2010).
- G. ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout 1999 (Reaffirmed 2010).
- H. ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout 1999 (Reaffirmed 2010).
- I. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework 2017.
- J. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units 2018.
- K. ANSI A108/A118/A136.1 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium). 2017.
- L. ANSI A108.12 - American National Standard for Installation of Ceramic Tile with EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar 1999 (Reaffirmed 2010).
- M. ANSI A108.13 - American National Standard for Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone 2005 (Reaffirmed 2016).
- N. ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive 2013 (Revised).
- O. ANSI A118.4 - American National Standard Specifications for Modified Dry-Set Cement Mortar 2012 (Revised).
- P. ANSI A118.6 - American National Standard Specifications for Standard Cement Grouts for Tile Installation 2010 (Reaffirmed 2016).
- Q. ANSI A118.7 - American National Standard Specifications for High Performance Cement Grouts for Tile Installation 2010 (Reaffirmed 2016).

- R. ANSI A118.10 - American National Standard Specifications for Load Bearing, Bonded, Waterproof Membranes For Thin-Set Ceramic Tile And Dimension Stone Installation 2014.
- S. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation 2014.
- T. ANSI A137.1 - American National Standard Specifications for Ceramic Tile 2019.
- U. ASTM C373 - Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products 2018.
- V. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring 2021.
- W. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride 2016a.
- X. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation 2019.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- C. Samples: Mount tile and apply grout on two plywood panels, minimum 18 by 18 inches in size illustrating pattern, color variations, and grout joint size variations.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Tile: 1 percent of each size, color, and surface finish combination.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.
- B. Installer Qualifications: Company specializing in performing tile installation, with minimum of five years of documented experience.

1.07 MOCK-UP

- A. See Section 014000 - Quality Requirements, for general requirements for mock-up.
- B. Construct tile mock-up where indicated on drawings, incorporating all components specified for the location.
 - 1. Minimum size of mock-up is indicated on drawings.
 - 2. Approved mock-up may remain as part of the Work.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.09 FIELD CONDITIONS

- A. Maintain ambient and substrate temperature of 50 degrees F during installation of mortar materials.

PART 2 PRODUCTS

2.01 TILE

- A. Porcelain Tile, Type []: ANSI A137.1, standard grade.
 - 1. Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.
 - 2. Size: as indicated on drawings.
 - 3. Color(s): As indicated on drawings.
 - 4. Pattern: As indicated on drawings.

2.02 TRIM AND ACCESSORIES

- A. Non-Ceramic Trim: Satin natural anodized extruded aluminum, style and dimensions to suit application, for setting using tile mortar or adhesive.
 - 1. Applications:
 - a. Open edges of wall tile.
 - b. Wall corners, outside and inside.
 - c. Transition between floor finishes of different heights.
 - d. Thresholds at door openings.
 - 2. Manufacturers:
 - a. Schluter-Systems: Schluter schiene - www.schluter.com.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.03 SETTING MATERIALS

- A. Manufacturers: provide setting materials by same manufacturer as grout.
- B. Latex-Portland Cement Mortar Bond Coat: ANSI A118.4.
 - 1. Products:
 - a. ARDEX Engineered Cements; ARDEX N 23 MICROTEC: www.ardexamericas.com/#sle.
 - b. Merkrete, by Parex USA, Inc; Merkrete 735 Premium Flex: www.merkrete.com/#sle.
 - c. TEC, an H.B. Fuller Construction Products Brand; TEC Ultimate Large Tile Mortar: www.tecspecialty.com/#sle.

2.04 GROUTS

2.05 THIN-SET ACCESSORY MATERIALS

- A. Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.
 - 1. Color(s): As indicated on drawings.
 - 2. Products:
 - a. LATICRETE International, Inc; LATICRETE SPECTRALOCK PRO Premium Grout: www.laticrete.com/#sle.

2.06 ACCESSORY MATERIALS

- A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.
 - 1. Thickness: 20 mils, maximum.
 - 2. Crack Resistance: No failure at 1/16 inch gap, minimum.
- B. Waterproofing Membrane at Showers and Tiled Tubs: Specifically designed for bonding to cementitious substrate under thick mortar bed or thin-set tile; complying with ANSI A118.10.
 - 1. Fluid or Trowel Applied Type:
 - a. Material: Synthetic rubber.
 - b. Thickness: 25 mils, minimum, dry film thickness.
 - c. Products:
 - 1) LATICRETE International, Inc; LATICRETE HYDRO BAN: www.laticrete.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.

- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.
- C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of setting materials to sub-floor surfaces.
- D. Verify that concrete sub-floor surfaces are ready for tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within limits recommended by tile manufacturer and setting materials manufacturer.

3.02 PREPARATION

- A. Protect surrounding work from damage.
- B. Vacuum clean surfaces and damp clean.
- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- D. Install backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to a feather edge.
- E. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.03 INSTALLATION - GENERAL

- A. Install tile and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.13, manufacturer's instructions, and TCNA (HB) recommendations.
- B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
- E. Form internal angles square and external angles bullnosed.
- F. Install non-ceramic trim in accordance with manufacturer's instructions.
- G. Sound tile after setting. Replace hollow sounding units.
- H. Keep control and expansion joints free of mortar, grout, and adhesive.
- I. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- J. Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.
- K. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

- A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, with standard grout, unless otherwise indicated.

3.05 INSTALLATION - WALL TILE

- A. Over coated glass mat backer board on studs, install in accordance with TCNA (HB) Method W245.

3.06 CLEANING

- A. Clean tile and grout surfaces.

3.07 PROTECTION

- A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION 093000

**SECTION 095100
ACOUSTICAL CEILINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.

1.02 REFERENCE STANDARDS

- A. ASTM C635/C635M - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings 2017.
- B. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels 2013.
- C. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions 2020.
- D. ASTM E1264 - Standard Classification for Acoustical Ceiling Products 2019.
- E. UL (FRD) - Fire Resistance Directory Current Edition.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical units until after interior wet work is dry.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on suspension system components and acoustical units.

1.05 QUALITY ASSURANCE

- A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acoustic Tiles/Panels:
 - 1. Armstrong World Industries, Inc: www.armstrong.com/#sle.
- B. Suspension Systems:
 - 1. Same as for acoustical units.

2.02 ACOUSTICAL UNITS

- A. Armstrong World Industries, Inc: www.armstrong.com.
- B. Acoustical Units - General: ASTM E1264, Class A.
 - 1. See drawings for product selections.
 - 2. VOC Content: As specified in Section 016116.

2.03 SUSPENSION SYSTEM(S)

- A. Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required. See system descriptions above.

- B. See drawings for product selections.

2.04 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application and ceiling system flatness requirement specified.
- B. Perimeter Moldings: Armstrong Shadow Molding 7874.
 - 1. At Exposed Grid: Provide L-shaped molding for mounting at same elevation as face of grid.
 - 2. At Concealed Grid: Provide concealed molding.
- C. Acoustical Insulation: ASTM C665 friction fit type, unfaced batts.
 - 1. Thickness: 2 inch.
 - 2. Size: To fit acoustical suspension system.
- D. Acoustical Sealant For Perimeter Moldings: Non-hardening, non-skinning, for use in conjunction with suspended ceiling system.
- E. Gasket For Perimeter Moldings: Closed cell rubber sponge tape.
- F. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.02 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.
- D. Locate system on room axis according to reflected plan.
- E. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.
- F. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- G. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- H. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- I. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- J. Do not eccentrically load system or induce rotation of runners.
- K. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.

3.03 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Fit border trim neatly against abutting surfaces.
- D. Install units after above-ceiling work is complete.

- E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- F. Cutting Acoustical Units:
 - 1. Make field cut edges of same profile as factory edges.
- G. Where round obstructions occur, provide preformed closures to match perimeter molding.
- H. Lay acoustical insulation for a distance of 48 inches either side of acoustical partitions as indicated.

3.04 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

END OF SECTION 095100

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**SECTION 095426
SUSPENDED WOOD CEILINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Linear wood planks.
- B. Metal suspension system.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. ASTM C635/C635M - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings 2017.
- B. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels 2013.
- C. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions 2020.
- D. CISCA (WC) - Wood Ceilings Technical Guidelines 2009.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure ceilings are not installed until building is enclosed, dust generating activities have terminated, and overhead work is completed.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate grid layout and related dimensioning, attachment of wood ceiling components to grid, accessory attachments, junctions with other ceiling finishes, and mechanical and electrical items installed in the ceiling.
- C. Product Data: Provide data on wood ceiling components and suspension system components.
- D. Samples: Submit two full size samples illustrating material and finish of wood ceiling components.
- E. Manufacturer's Qualification Statement.
- F. Installer's Qualification Statement.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section.
 - 1. Minimum 3 years documented experience.
- C. Design Criteria: Manufacturer of Linear Closed wood wall and ceiling system LC-1-xxxx-C shall be installed true and plumb to within manufacturing tolerance of 1/8" within 8' of length.
- D. Product Construction: Wood shall be kiln dried to 10%. Cracking, checking and warpage of members will not be acceptable.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wood ceiling components to project site in original, unopened packages.
- B. Store in fully enclosed space, flat, level and off the floor.

1.08 FIELD CONDITIONS

- A. Do not install suspended wood ceiling system until wet construction work is complete and permanent heat and air conditioning is installed and operating.
- B. Maintain room temperature between 60 degrees F and 75 degrees F and relative humidity between 35 to 55 percent before, during, and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Suspended Wood Ceilings:
 - 1. Basis of Design: Architectural Components Group Inc; Linear Close Series 1 Wood Wall & Ceiling System: www.acgiwood.com/product_detail/Linear/393

2.02 SUSPENDED WOOD CEILING SYSTEM

- A. Performance Requirements:
 - 1. Design for maximum deflection of 1/360 of span.
- B. Linear Wood Planks: Solid wood.
 - 1. Type: Pre-assembled module of linear planks with battens attached perpendicularly to back of planks.
 - a. Plank Thickness: 3/4 inch.
 - b. Plank Width: 6 inches, nominal.
 - c. Plank Spacing (Reveal): Reveal C by ACGI.
 - d. Species: White Oak.
 - e. Finish: stain to match architect's sample.
- C. Metal Suspension System (Ceilings):
 - 1. General: Comply with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
 - 2. Concealed Suspension System: Hot-dipped galvanized steel grid and cap.
 - a. Structural Classification: Heavy-duty, when tested in accordance with ASTM C635/C635M.
 - b. Profile: Tee; 15/16 inch face width.
 - c. Finish/Color: Baked enamel, black.
 - 3. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement.
- D. Wall Attachment System: per design details provided on the plans.
- E. Accessories: Manufacturer's standard accessories for installation method indicated, above-ceiling accessibility.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Do not install ceiling until after interior wet work is dry.

3.02 PREPARATION

- A. Layout wood ceiling components in pattern according to reflected ceiling plan and as shown on shop drawings.
- B. Acclimate wood ceiling materials by removing from packaging in installation area a minimum of 48 hours prior to installation.

3.03 INSTALLATION

- A. General: Install suspended wood ceiling system in accordance with CISCA (WC).
- B. Suspension System:
 - 1. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.
 - 2. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
 - 3. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

4. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
 5. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
 6. Do not eccentrically load system or induce rotation of runners.
- C. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
- D. Wood Ceiling:
1. Install wood ceilings in accordance with manufacturer's instructions.
 2. Fit wood components in place, free from damaged edges or other defects detrimental to appearance and function.
 3. Install components in uniform plane, and free from twist, warp, and dents.
 4. Cut to fit irregular grid and perimeter edge trim.
 5. Make field cut edges of same profile as factory edges, seal and finish according to manufacturer.
 6. Install alignment clips at plank joints.

3.04 CLEANING

- A. Clean and touch up minor finish damage. Remove and replace components that cannot be successfully cleaned and repaired.

END OF SECTION 095426

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**SECTION 096500
RESILIENT FLOORING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Resilient base.
- B. Installation accessories.

1.02 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Verification Samples: Submit two samples, 4 by 4 inch in size illustrating color and pattern for each resilient flooring product specified.
- D. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of sub-floor is acceptable.
- E. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in installing specified flooring with minimum 5 years documented experience.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
- B. Store all materials off of the floor in an acclimatized, weather-tight space.
- C. Maintain temperature in storage area between 55 degrees F and 90 degrees F.
- D. Protect roll materials from damage by storing on end.
- E. Do not double stack pallets.

1.05 FIELD CONDITIONS

- A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS

2.01 RESILIENT BASE

- A. Resilient Base: ASTM F1861, Type TP, rubber, thermoplastic; top set Style B, Cove.
 - 1. Manufacturers:
 - a. Basis of design: Johnsonite, a Tarkett Company: Perceptions, Flex.
 - 2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 - 3. Thickness: 0.125 inch.
 - 4. Length: Roll.
 - 5. Color and size: As indicated on drawings.
 - 6. Accessories: Premolded external corners and internal corners.

2.02 ACCESSORIES

- A. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.

1. VOC Content Limits: As specified in Section 016116.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for resilient flooring installation by testing for moisture and pH.
 1. Test in accordance with ASTM F710.
 2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

3.02 PREPARATION

- A. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed.

3.03 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install in accordance with manufacturer's written instructions.
- C. Adhesive-Applied Installation:
 1. Fit joints and butt seams tightly.
 2. Set flooring in place, press with heavy roller to attain full adhesion.
- D. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
- E. Spread only enough adhesive to permit installation of materials before initial set.
- F. Fit joints and butt seams tightly.
- G. Set flooring in place, press with heavy roller to attain full adhesion.
- H. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
 1. Resilient Strips: Attach to substrate using adhesive.
- I. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.
- J. Install flooring in recessed floor access covers, maintaining floor pattern.

3.04 INSTALLATION - RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.
- B. Install base on solid backing. Bond tightly to wall and floor surfaces.
- C. Scribe and fit to door frames and other interruptions.

3.05 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's written instructions.

3.06 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION 096500

**SECTION 096813
TILE CARPETING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Carpet tile, fully adhered.

1.02 REFERENCE STANDARDS

- A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials 2016 (Reapproved 2021).
- B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source 2019a, with Editorial Revision (2020).
- C. CRI 104 - Standard for Installation of Commercial Carpet 2015.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- C. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
- D. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

1.05 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Tile Carpeting: Textured patterned loop, manufactured in one color dye lot.
 - 1. Basis of Design: Mountain Fold by Mannington Commercial.
 - 2. Tile Size: 24" x 24", nominal.
 - 3. Pile Thickness: 0.140 inch.
 - 4. Color: as indicated on drawings.
 - 5. Pattern: Monolithic.
 - 6. Critical Radiant Flux: Minimum of 0.45 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
 - 7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").
 - 8. VOC Content: Comply with Section 016116.
 - 9. Gauge: 5/64 inch.
 - 10. Stitches: 8.83 per inch.
 - 11. Pile Weight: 24 oz/sq yd.
 - 12. Primary Backing Material: 100% Synthetic.
 - 13. Fiber System: Antron Legacy or Antron Lumena Type 6, 6 Nylon.

2.02 ACCESSORIES

- A. Edge Strips: Rubber, color as selected by Architect.
- B. Adhesives:
 - 1. Compatible with materials being adhered; maximum VOC content as specified in Section 016116.
- C. Carpet Tile Adhesive: Recommended by carpet tile manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that sub-floor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
- B. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to sub-floor surfaces.
- C. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for flooring installation by testing for moisture and pH.
 - 1. Test in accordance with ASTM F710.
 - 2. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.

3.02 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- B. Remove sub-floor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with sub-floor filler.
- C. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.
- D. Vacuum clean substrate.

3.03 INSTALLATION

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions.
- C. Blend carpet from different cartons to ensure minimal variation in color match.
- D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.
- F. Locate change of color or pattern between rooms under door centerline.
- G. Fully adhere carpet tile to substrate.
- H. Trim carpet tile neatly at walls and around interruptions.
- I. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

- A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- B. Clean and vacuum carpet surfaces.

END OF SECTION 096813

**SECTION 097200
WALL COVERINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation and prime painting.
- B. Wall covering.

1.02 RELATED REQUIREMENTS

- A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

1.03 REFERENCE STANDARDS

- A. ASTM D1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems 2020.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- C. ASTM F793/F793M - Standard Classification of Wall Coverings by Use Characteristics 2015.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on wall covering and adhesive.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum 5 years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least 5 years of documented experience.

1.06 WARRANTY

- A. Manufacturer's limited 5-year written warranty against manufacturing defects.

1.07 MOCK-UP

- A. Provide panel, 8 feet wide, full height, illustrating installed wall covering and joint seaming technique.
- B. Locate where directed.
- C. Mock-up may remain as part of the Work.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Inspect roll materials at arrival on site, to verify acceptability.
- B. Protect packaged adhesive from temperature cycling and cold temperatures.
- C. Do not store roll goods on end.

1.09 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the adhesive or wall covering product manufacturer.
- B. Maintain these conditions 24 hours before, during, and after installation of adhesive and wall covering.

PART 2 PRODUCTS

2.01 WALL COVERINGS

- A. General Requirements:
 - 1. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.

2. Chemical and Stain Resistance: No visible staining or discoloration and no damage to surface texture when tested in accordance with ASTM D1308.
- B. Tackable Wallcovering
1. Basis of design:
 - a. Product: Tac-Wall
 - b. Manufacturer: Koroseal
 - c. Width: 72"
 - d. Gauge: 1/4"
 - e. Color: as indicated on drawings.
- C. Wall Covering: Fabric-backed vinyl roll stock.
1. Comply with ASTM F793/F793M, Category V, Type II.
 2. Color: Varies, as indicated on drawings.
 3. Pattern: Varies, as indicated on drawings..
 4. Micro-perforation requirement: All wall covering installed on exterior walls must be factory perforated to allow moisture transmission.
- D. Adhesive: Type recommended by wall covering manufacturer to suit application to substrate.
- E. Termination Trim: Extruded plastic, color as selected.
- F. Substrate Filler: As recommended by adhesive and wall covering manufacturers; compatible with substrate.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are prime painted and ready to receive work, and comply with requirements of wall covering manufacturer.
- B. Measure moisture content of surfaces using an electronic moisture meter. Do not apply wall coverings if moisture content of substrate exceeds level recommended by wall covering manufacturer.
- C. Verify flatness tolerance of surfaces does not vary more than 1/8 inch in 10 feet nor vary at a rate greater than 1/16 inch/ft.

3.02 PREPARATION

- A. Fill cracks in substrate and smooth irregularities with filler; sand smooth.
- B. Wash impervious surfaces with tetra-sodium phosphate, rinse and neutralize; wipe dry.
- C. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
- D. Vacuum clean surfaces free of loose particles.

3.03 INSTALLATION

- A. Apply adhesive and wall covering in accordance with manufacturer's instructions.
- B. Apply adhesive to wall surface immediately prior to application of wall covering.
- C. Apply wall covering smooth, without wrinkles, gaps or overlaps. Eliminate air pockets and ensure full bond to substrate surface.
- D. Butt edges tightly.
- E. Do not seam within 2 inches of internal corners or within 6 inches of external corners.
- F. Install wall covering before installation of bases and items attached to or spaced slightly from wall surface.
- G. Cover spaces above and below windows, above doors, in pattern sequence from roll.
- H. Where wall covering tucks into reveals, or metal wallboard or plaster stops, apply with contact adhesive within 6 inches of wall covering termination. Ensure full contact bond.
- I. Install termination trim.

- J. Remove excess adhesive while wet from seam before proceeding to next wall covering sheet.
Wipe clean with dry cloth.

3.04 CLEANING

- A. Clean wall coverings of excess adhesive, dust, dirt, and other contaminants.
- B. Reinstall wall plates and accessories removed prior to work of this section.

3.05 PROTECTION

- A. Do not permit construction activities at or near finished wall covering areas.

END OF SECTION 097200

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**SECTION 098430
SOUND-ABSORBING WALL AND CEILING UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sound-absorbing panels.
- B. Mounting accessories.

1.02 RELATED REQUIREMENTS

- A. Section 095100 - Acoustical Ceilings: Ceiling suspension system.

1.03 REFERENCE STANDARDS

- A. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method 2017.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- C. ASTM E795 - Standard Practices for Mounting Test Specimens During Sound Absorption Tests 2016.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's printed data sheets for products specified.
- C. Shop Drawings: Fabrication and installation details, panel layout, and fabric orientation.
- D. Verification Samples: Fabricated samples of each type of panel specified; 12 by 12 inch, showing construction, edge details, and fabric covering.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company with not less than five years of experience in manufacturing acoustical products similar to those specified.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect acoustical units from moisture during shipment, storage, and handling. Deliver in factory-wrapped bundles; do not open bundles until units are needed for installation.
- B. Store units flat, in dry, well-ventilated space; do not stand on end.
- C. Protect edges from damage.

PART 2 PRODUCTS

2.01 FABRIC-COVERED SOUND-ABSORBING UNITS

- A. Sound Absorbing Units: Prefinished, factory assembled fabric-covered panels.
 - 1. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
- B. Fabric-Covered Acoustical Panels for Walls and Ceilings:
 - 1. Panel Core: Manufacturer's standard rigid or semi-rigid fiberglass core.
 - 2. Multiple panel types as indicated on drawings.
 - 3. Color: As indicated.
 - 4. Mounting Method: Spline-mounted, concealed.
 - 5. Mounting Method: Horizontally suspended from ceiling.

2.02 WOOD VENEER SOUND-ABSORBING UNITS

- A. Manufacturers:
 - 1. Basis of design: Aluratone System as manufactured by Rulon International.

- B. Wood Veneer Acoustical Panels for Walls: Medium Density Fiberboard (MDF) core panels with prime grade finished face veneer and non-woven acoustic material adhered to back of panel.
 - 1. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - 2. Noise Reduction Coefficient (NRC): 0.80 to 0.90 when tested in accordance with ASTM C423 for Type A mounting, per ASTM E795.

2.03 FABRICATION

- A. Fabric Wrapped, General: Fabricate panels to sizes and configurations as indicated, with fabric facing installed without sagging, wrinkles, blisters, or visible seams.
- B. Tolerances: Fabricate to finished tolerance of plus or minus 1/16 inch for thickness, overall length and width, and squareness from corner to corner.
- C. Factory-applied finishes on wood veneer panels to be uniform, smooth, and without blemishes.

2.04 ACCESSORIES

- A. Spline-Mounting Accessories: Manufacturer's standard concealed connecting splines of extruded aluminum designed for screw attachment to walls, with coordinating moldings and trim for interior and exterior corners and miscellaneous conditions.
 - 1. Color of Exposed Trim: As selected from manufacturer's standards.
- B. Back-Mounting Accessories: Manufacturer's standard accessories for concealed support, designed to allow panel removal, and as follows:
 - 1. Two-part clip and base-support bracket system; brackets designed to support full weight of panels and clips designed for lateral support, with one part mechanically attached to back of panel and the other attached to substrate.
- C. Ceiling-Suspended Accessories: Manufacturer's standard accessories at locations as indicated on each acoustical unit, sized appropriately for weight of acoustical unit.
- D. Fixing Clips: Manufacturer's standard for application as indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates for conditions detrimental to installation of acoustical units. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install acoustical units in locations as indicated, following manufacturer's installation instructions.
- B. Align panels accurately, with edges plumb and top edges level. Scribe to fit accurately at adjoining work and penetrations.
- C. Suspend ceiling baffles at locations and heights as indicated.
- D. Install acoustical units to construction tolerances of plus or minus 1/16 inch for the following:
 - 1. Plumb and level.
 - 2. Flatness.

3.03 CLEANING

- A. Clean fabric facing upon completion of installation from dust and other foreign materials, following manufacturer's instructions.

3.04 PROTECTION

- A. Provide protection of installed acoustical panels until Date of Substantial Completion.
- B. Replace panels that cannot be cleaned and repaired to satisfaction of the Architect.

END OF SECTION 098430

**SECTION 099113
EXTERIOR PAINTING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints, stains, and varnishes.
- C. Scope: Finish exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
 - 1. Exposed surfaces of steel lintels and ledge angles.
- D. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
 - 5. Stainless steel, anodized aluminum, bronze, terne coated stainless steel, zinc, and lead.
 - 6. Floors, unless specifically indicated.
 - 7. Brick, glass unit masonry, architectural concrete, cast stone, integrally colored plaster and stucco.
 - 8. Glass.
 - 9. Concealed pipes, ducts, and conduits.

1.02 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
 - 2. MPI product number (e.g. MPI #47).
 - 3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum 10 years documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 5 years experience and approved by manufacturer.

1.04 MOCK-UP

- A. See Section 014000 - Quality Requirements, for general requirements for mock-up.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.06 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply exterior paint and finishes during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- D. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.
- B. Paints:
 - 1. PPG Paints: www.ppgpaints.com/#sle.
 - 2. Sherwin-Williams Company: www.sherwin-williams.com/#sle.

2.02 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready mixed, unless required to be a field-catalyzed paint.
 - 1. Where MPI paint numbers are specified, provide products listed in Master Painters Institute Approved Product List, current edition available at www.paintinfo.com, for specified MPI categories, except as otherwise indicated.
 - 2. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 3. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
 - 4. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 5. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Volatile Organic Compound (VOC) Content: Comply with Section 016116.
- C. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.
- D. Colors: To be selected from manufacturer's full range of available colors.
 - 1. Selection to be made by Architect after award of contract.

2.03 PAINT SYSTEMS - EXTERIOR

- A. Paint E-OP - Exterior Surfaces to be Painted, where indicated: concrete.
 - 1. Two top coats and one coat primer.
 - 2. Top Coat(s): Exterior Light Industrial Coating, Water Based; MPI # 163.
 - a. Application: General, all exterior primed metal including exposed structural steel, hollow metal doors and frames.
 - b. Products:
 - 1) PPG Paints Pitt-Tech Plus WB DTM Industrial Enamel, 90-1210 Series, Semi-Gloss. (MPI #163)
 - 3. Top Coat(s): Exterior High Build Latex; MPI #40.
 - a. Application: General, concrete and concrete masonry units. Apply at CMU, back side of loading dock masonry walls.
 - b. Products:
 - 1) PPG Paints Perma-Crete Exterior Acrylic High Build, 4-22 Series.
- B. Paint E-OP-FL - Concrete floors to be Painted.
 - 1. Application: floor graphics for life safety egress zones.
 - 2. Two top coats without primer.
 - 3. Top Coat(s): Latex Floor Paint, Gloss.
 - a. Products:

- 1) PPG Paints Floor and Porch Enamel WB Alkyd, 3-610 Series, Gloss.

2.04 PRIMERS

- A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.
 1. Interior/Exterior Latex Block Filler; MPI #4.
 - a. Products:
 - 1) Kilz Pro-X p50 Block Filler Primer.
 2. Anti-Corrosive Alkyd Primer for Metal; MPI #79.
 - a. Products:
 - 1) PPG Paints Speedhide Interior/Exterior Rust Inhibitive Steel Primer, 6-212 Series. (MPI #79)

2.05 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.
- C. Test shop-applied primer for compatibility with subsequent cover materials.
- D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 1. Exterior Plaster and Stucco: 12 percent.
 2. Masonry, Concrete, and Concrete Masonry Units: 12 percent.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces for finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- F. Concrete:
 1. 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.
 2. Clean surfaces with pressurized water. Use pressure range of 1,500 to 4,000 psi at 6 to 12 inches. Allow to dry.
 3. Clean concrete according to ASTM D4258. Allow to dry.
- G. Masonry:
 1. Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions. Allow to dry.
 2. Prepare surface as recommended by top coat manufacturer.
 3. Clean surfaces with pressurized water. Use pressure range of 600 to 1,500 psi at 6 to 12 inches. Allow to dry.

- H. Exterior Plaster: Fill hairline cracks, small holes, and imperfections with exterior patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
- I. Galvanized Surfaces:
 - 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
 - 2. Prepare surface according to SSPC-SP 2.
- J. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
 - 3. Remove rust, loose mill scale, and other foreign substances using using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 "Commercial Blast Cleaning". Protect from corrosion until coated.
- K. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

- A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- C. Apply each coat to uniform appearance.
- D. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply additional coats until complete hide is achieved.
- E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- F. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.05 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 099113

**SECTION 099123
INTERIOR PAINTING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints.
- C. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
 - 1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 - 2. Elevator pit ladders.
 - 3. Prime surfaces to receive wall coverings.
- D. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
 - 5. Stainless steel, anodized aluminum, bronze, terne coated stainless steel, and lead items.
 - 6. Marble, granite, slate, and other natural stones.
 - 7. Floors, unless specifically indicated.
 - 8. Ceramic and other tiles.
 - 9. Brick, architectural concrete, cast stone, integrally colored plaster and stucco.
 - 10. Glass.
 - 11. Acoustical materials, unless specifically indicated.
 - 12. Concealed pipes, ducts, and conduits.

1.02 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency current edition.
- B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications 2016.
- C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials 2020.
- D. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association Current Edition.
- E. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual Current Edition.
- F. SSPC-SP 1 - Solvent Cleaning 2015, with Editorial Revision (2016).
- G. SSPC-SP 2 - Hand Tool Cleaning 2018.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
 - 2. MPI product number (e.g. MPI #47).
 - 3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.

4. Manufacturer's installation instructions.
- C. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
 1. Where sheen is specified, submit samples in only that sheen.
 2. Allow 30 days for approval process, after receipt of complete samples by Architect.
- D. Certification: By manufacturer that paints and finishes comply with VOC limits specified.
- E. Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, product technical data sheets, material safety data sheets (MSDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 016000 - Product Requirements, for additional provisions.
 2. Extra Paint and Finish Materials: 1 gallon of each color; from the same product run, store where directed.
 3. Label each container with color in addition to the manufacturer's label.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum 10 years documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 10 years of documented experience.

1.05 MOCK-UP

- A. See Section 014000 - Quality Requirements, for general requirements for mock-up.
- B. Provide panel, 4 feet long by 8 feet wide, illustrating paint color, texture, and finish.
- C. Provide door and frame assembly illustrating paint color, texture, and finish.
- D. Locate where directed by Architect.
- E. Mock-up may remain as part of the work.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.07 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide paints and finishes from the same manufacturer.
 1. In the event that a single manufacturer cannot provide specified products, minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for substitutions.
 2. Substitution of MPI-approved products by a different manufacturer is preferred over substitution of unapproved products by the same manufacturer.

- B. Paints:
 - 1. PPG Paints: www.ppgpaints.com/#sle.
 - 2. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
- C. Transparent Finishes:
 - 1. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
- D. Stains:
 - 1. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
 - 2. PPG Paints Deft Interior Clears/Polyurethanes: www.ppgpaints.com/#sle.
- E. Primer Sealers: Same manufacturer as top coats.
- F. Substitutions: See Section 016000 - Product Requirements.

2.02 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready mixed, unless intended to be a field-catalyzed paint.
 - 1. Where MPI paint numbers are specified, provide products listed in Master Painters Institute Approved Product List, current edition available at www.paintinfo.com, for specified MPI categories, except as otherwise indicated.
 - 2. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 3. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 - 4. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
 - 5. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 6. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Volatile Organic Compound (VOC) Content:
 - 1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
 - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - b. Architectural coatings VOC limits of the State in which the Project is located.
 - c. USGBC LEED Rating System; for interior wall and ceiling finish (all coats), anti-corrosive paints on interior ferrous metal, sanding sealers, other sealers, and floor coatings.
 - 2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.
- C. Flammability: Comply with applicable code for surface burning characteristics.
- D. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.
- E. Colors: As indicated on drawings.

2.03 PAINT SYSTEMS - INTERIOR

- A. Paint I-OP - Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, wood, uncoated steel, shop primed steel, and galvanized steel.
 - 1. Two top coats and one coat primer.
 - 2. Top Coat(s): Institutional Low Odor/VOC Interior Latex; MPI #143, 144, 145, 146, 147, or 148.
 - a. Products:
 - 1) PPG Paints Speedhide zero Latex, 6-4310XI Series, Eggshell. (MPI #144)

3. Top Coat Sheen:
 - a. Flat: MPI gloss level 1; use this sheen for ceilings and other overhead surfaces.
 - b. Eggshell: MPI gloss level 3; use this sheen at walls.
 4. Primer: As recommended by top coat manufacturer for specific substrate.
- B. Medium Duty Door/Trim: For surfaces subject to frequent contact by occupants, including:
1. Medium duty applications include door frames.
 2. Two top coats and one coat primer.
 3. Top Coat(s): High Performance Architectural Interior Latex; MPI #139, 140, or 141.
 - a. Products:
 - 1) PPG Paints Pitt-Tech Plus WB DTM Industrial Enamel, 90-1210 Series, Semi-Gloss.
 - 2) Sherwin-Williams Pro Industrial Pre-Catalyzed Waterbased Epoxy, Semi-Gloss. (MPI #141)
- C. Paint I-TR -W - Transparent Finish on Wood (Type: M2.1).
1. Stain: Semi-Transparent Stain for Wood; MPI #90.
 - a. Products:
 - 1) Sherwin-Williams Wood Classics 250 VOC Oil Stain. (MPI #90)
 2. Top Coat(s): Clear Lacquer; MPI #85, 86, or 87.
 3. Top Coat Sheen:
 - a. Satin: MPI gloss level 4; use this sheen at all locations.
- D. Paint WI-OP-2L - Wood, Opaque, Latex, 2 Coat (Type P2.1) :
1. One coat of latex primer sealer.
 2. Satin: One coat of latex enamel; Wolf Gordon.

2.04 PRIMERS

- A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.

2.05 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin application of paints and finishes until substrates have been properly prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.
- D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- E. Test shop-applied primer for compatibility with subsequent cover materials.
- F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
1. Gypsum Wallboard: 12 percent.
 2. Interior Wood: 15 percent, measured in accordance with ASTM D4442.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- F. Galvanized Surfaces:
 - 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
 - 2. Prepare surface according to SSPC-SP 2.
- G. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
 - 3. Remove rust, loose mill scale, and other foreign substances using using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 "Commercial Blast Cleaning". Protect from corrosion until coated.
- H. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.
- I. Wood Surfaces to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats. Prime concealed surfaces with gloss varnish reduced 25 percent with thinner.
- J. Wood Doors to be Field-Finished: Seal wood door top and bottom edge surfaces with clear sealer.
- K. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

- A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- C. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- D. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- E. Sand wood and metal surfaces lightly between coats to achieve required finish.
- F. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- G. Wood to Receive Transparent Finishes: Tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- H. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.05 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 099123

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**SECTION 099600
HIGH-PERFORMANCE COATINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. High performance coatings.
- B. Surface preparation.

1.02 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency current edition.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- C. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association Current Edition.
- D. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual Current Edition.
- E. SSPC V1 (PM1) - Good Painting Practice: Painting Manual, Volume 1 2016.
- F. SSPC V2 (PM2) - Systems and Specifications: Steel Structures Painting Manual, Volume 2 2015.
- G. SSPC-PA 1 - Shop, Field, and Maintenance Painting of Steel 2016.
- H. SSPC-PA 2 - Procedure For Determining Conformance To Dry Coating Thickness Requirements 2015, with Editorial Revision (2018).
- I. SSPC-SP 1 - Solvent Cleaning 2015, with Editorial Revision (2016).
- J. SSPC-SP 6 - Commercial Blast Cleaning 2007.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide complete list of all products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
 - 2. MPI product number (e.g. MPI #47).
 - 3. Cross-reference to specified coating system(s) product is to be used in; include description of each system.
- C. Samples: Submit two samples 8 by 8 inch in size illustrating colors available for selection.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- F. Maintenance Data: Include cleaning procedures and repair and patching techniques.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Coating Materials: 1 gallon of each type and color.
 - 2. Label each container with manufacturer's name, product number, color number, and room names and numbers where used.

1.04 QUALITY ASSURANCE

- A. Maintain one copy of each referenced document that applies to application on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum 10 years documented experience.

- C. Applicator Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience.

1.05 MOCK-UP

- A. See Section 014000 - Quality Requirements, for general requirements for mock-up.
- B. Locate where directed.
- C. Mock-up may remain as part of the work.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Coating Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.07 FIELD CONDITIONS

- A. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- B. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the coating product manufacturer.
- C. Do not install materials when temperature is below 55 degrees F or above 90 degrees F.
- D. Maintain this temperature range, 24 hours before, during, and 72 hours after installation of coating.
- E. Restrict traffic from area where coating is being applied or is curing.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Warranty: Include coverage for bond to substrate.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide high performance coating products from the same manufacturer to the greatest extent possible.
- B. High-Performance Coatings:
 - 1. PPG Paints; [____]: www.ppgpaints.com/#sle.
 - 2. Sherwin-Williams Company; [____]: www.protective.sherwin-williams.com/industries/#sle.
 - 3. Substitutions: Section 016000 - Product Requirements.

2.02 HIGH-PERFORMANCE COATINGS

- A. Provide the following: One top coat and one coat primer.
- B. Note: Certain colors may require multiple coats depending on method of application and finish coat color. When feasible, the preceding coat should be in the same color family (blue, gray, etc.), but noticeably different.
- C. MPI Standards: Provide products that comply with MPI standards indicated and are listed in "MPI Approved Products List."

2.03 TOP COAT MATERIALS

- A. Coatings - General: Provide complete multi-coat systems formulated and recommended by manufacturer for the applications indicated, in the thicknesses indicated; number of coats specified does not include primer or filler coat.

- B. Epoxy Coating for wet locations:
 - 1. Number of coats: Two.
 - 2. Top Coat(s): High Performance Institutional, Two-Component, Water Based Epoxy Coating; MPI #254.
 - a. Sheen: Eggshell.
 - b. Products:
 - 1) PPG Paints; Pitt-Glaze WB Water-Borne Acrylic Epoxy 16-598 Series, Gloss/16-599 Series, Semi-Gloss: www.ppgpaints.com/#sle.
 - 2) Sherwin-Williams; Pro Industrial Water Based Catalyzed Epoxy; MPI #254: www.protective.sherwin-williams.com/#sle.
- C. Polyurethane Floor Coating for exterior loading dock:
 - 1. Top Coat(s): Industrial Floor Coating, Thin Film; MPI #212.
 - a. Sheen: Gloss.
 - b. Products:
 - 1) PPG Paints; Megaseal HPU HP Urethane Floor Coating, 99-1900 Series: www.ppgpaints.com/#sle.
 - 2) Sherwin-Williams; ArmorSeal HS Polyurethane Floor Enamel; MPI #212: www.protective.sherwin-williams.com/#sle.
 - 3) Substitutions: Section 016000 - Product Requirements.
 - 2. Primer: As recommended by coating manufacturer for specific substrate.
- D. Shellac: Pure, white type.

2.04 PRIMERS

- A. Primers: Provide the following unless other primer is required or recommended by coating manufacturer.
 - 1. Primer Sealer, Interior, Institutional Low Odor; MPI #149.
 - a. Products:
 - 1) PPG Paints; Speedhide zero Interior Latex Sealer, 6-4900XI; MPI #149: www.ppgpaints.com/#sle.
 - 2) Sherwin-Williams; ProMar 200 Zero VOC Interior Latex Primer; MPI #149: www.protective.sherwin-williams.com/#sle.
 - 2. Block Filler, Epoxy; MPI #116.
 - a. Products:
 - 1) PPG Paints; Amerlock 400 Epoxy Block Filler, 400BF: www.ppgpaints.com/#sle.

2.05 ACCESSORY MATERIALS

- A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of coated surfaces.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Do not begin application of coatings until substrates have been properly prepared.
- C. Verify that substrate surfaces are ready to receive work as instructed by the coating manufacturer. Obtain and follow manufacturer's instructions for examination and testing of substrates.
- D. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- E. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- F. Proceed with coating application only after unacceptable conditions have been corrected.

3.02 PREPARATION

- A. Clean surfaces of loose foreign matter.
- B. Remove substances that would bleed through finished coatings. If unremovable, seal surface with shellac.
- C. Remove finish hardware, fixture covers, and accessories and store.
- D. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Remove rust, loose mill scale, and other foreign substances using using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 "Commercial Blast Cleaning", and protect from corrosion until coated.
- E. Protect adjacent surfaces and materials not receiving coating from spatter and overspray; mask if necessary to provide adequate protection. Repair damage.

3.03 PRIMING

- A. Apply primer to all surfaces, unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.

3.04 COATING APPLICATION

- A. Apply coatings in accordance with manufacturer's written instructions, to thicknesses specified and recommendations in "MPI Architectural Painting and Specification Manual".
- B. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.
- B. Clean surfaces immediately of overspray, splatter, and excess material.
- C. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.06 PROTECTION

- A. Protect finished work from damage.

END OF SECTION 099600

**SECTION 101400
SIGNAGE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Room and door signs.

1.02 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines current edition.
- B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- C. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, foreground and background colors, locations, overall dimensions of each sign.
- C. Signage Schedule: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.
 - 1. When room numbers to appear on signs differ from those on drawings, include the drawing room number on schedule.
 - 2. When content of signs is indicated to be determined later, request such information from Owner through Architect at least 2 months prior to start of fabrication; upon request, submit preliminary schedule.
 - 3. Submit for approval by Owner through Architect prior to fabrication.
- D. Selection Samples: Where colors are not specified, submit two sets of color selection charts or chips.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years of documented experience.

1.05 FIELD CONDITIONS

- A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.
- B. Maintain this minimum temperature during and after installation of signs.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Flat Signs:
 - 1. Best Sign Systems, Inc; [____]: www.bestsigns.com/#sle.
 - 2. FASTSIGNS; [____]: www.fastsigns.com/#sle.
 - 3. Mohawk Sign Systems, Inc; [____]: www.mohawksign.com/#sle.
- B. Plaques:

2.02 SIGNAGE APPLICATIONS

- A. Accessibility Compliance: Signs are required to comply with ADA Standards and ICC A117.1, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.
- B. Room and Door Signs: Provide a sign for every doorway, whether it has a door or not, not including corridors, lobbies, and similar open areas.
 - 1. Sign Type: Flat signs with engraved panel media as specified.
 - 2. Provide "tactile" signage, with letters raised minimum 1/32 inch and Grade II braille.

3. Character Height: 1 inch.
 4. Sign Height: 2 inches, unless otherwise indicated.
 5. Office Doors: Identify with room numbers to be determined later, not the numbers indicated on drawings; in addition, provide "window" section for replaceable occupant name.
 6. Conference and Meeting Rooms: Identify with room numbers to be determined later, not the numbers indicated on drawings; in addition, provide "window" section with sliding "In Use/Vacant" indicator.
 7. Service Rooms: Identify with room names and numbers to be determined later, not those indicated on drawings.
 8. Rest Rooms: Identify with pictograms, the names "MEN" and "WOMEN", room numbers to be determined later, and braille.
- C. Plaque: See Allowance for details.

2.03 SIGN TYPES

- A. Flat Signs: Signage media without frame.
1. Edges: Square.
 2. Corners: Square.
 3. Wall Mounting of One-Sided Signs: Tape adhesive.
- B. Color and Font: Unless otherwise indicated:
1. Character Font: Helvetica, Arial, or other sans serif font.
 2. Character Case: Upper case only.
 3. Background Color: Clear.
 4. Character Color: Contrasting color.

2.04 TACTILE SIGNAGE MEDIA

- A. Engraved Panels: Laminated colored plastic; engraved through face to expose core as background color:
1. Total Thickness: 1/16 inch.

2.05 PLAQUES

- A. Metal Plaques:
1. Metal: Bronze casting.
 2. Metal Sheet Thickness: 3/8" inch, minimum.

2.06 ACCESSORIES

- A. Concealed Screws: Stainless steel, galvanized steel, chrome plated, or other non-corroding metal.
- B. Tape Adhesive: Double sided tape, permanent adhesive.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install neatly, with horizontal edges level.
- C. Protect from damage until Substantial Completion; repair or replace damaged items.

END OF SECTION 101400

**SECTION 102113.10
SOLID PLASTIC TOILET COMPARTMENTS (STANDARD)**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Solid plastic toilet compartments including the following: (Hiny Hiders)
 - 1. Floor mounted overhead-braced toilet compartments.

1.02 RELATED SECTIONS

- A. Section 05 50 00 - Metal Fabrications.
- B. Section 06 10 00 - Rough Carpentry.

1.03 REFERENCES

- A. ASTM A 666 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- B. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- C. National Fire Protection Association (NFPA) 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.
- D. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings: Provide layout drawings and installation details with location and type of hardware required.
- D. Verification Samples: For each finish product specified, two samples representing actual product, color, and patterns.
- E. Sustainable Design Submittals:
 - 1. Recycled Content: Certify percentages of post-consumer and pre-consumer recycled content.
 - 2. Regional Materials: Certify distance between manufacturer and Project and between manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A company regularly engaged in manufacture of products specified in this section, and whose products have been in satisfactory use under similar service conditions for not less than 5 years.
- B. Installer Qualifications: A company regularly engaged in installation of products specified in this Section, with a minimum of 5 years experience.
- C. Materials: Doors, panels and pilasters, constructed from high density polyethylene (HDPE) resins. Partitions to be fabricated from polymer resins compounded under high pressure, forming a single component which is waterproof, nonabsorbent and has a self-lubricating surface that resists marks from pens, pencils, markers and other writing instruments. Cover all plastic components with a protective plastic masking.
- D. Performance Requirements:
 - 1. Fire Resistance: Partition materials shall comply with the following requirements, when tested in accordance with ASTM E 84:
 - a. Class A flame spread/smoke developed rating.

- b. Class B flame spread/smoke developed rating.
- 2. Material Fire Ratings:
 - a. National Fire Protection Association (NFPA) 286: Pass.
 - b. International Code Council (ICC): Class B.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.

1.07 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.08 WARRANTY

- A. Manufacturer guarantees its plastic against breakage, corrosion, and delamination under normal conditions for 25 years from the date of receipt by the customer. If materials are found to be defective during that period for reasons listed above, the materials will be replaced free of charge. Labor not included in warranty.

PART 1 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer: Scranton Products, which is located at: 801 E. Corey St.; Scranton, PA 18505; Toll Free Tel: 800-445-5148; Fax: 855-376-6161; Email: request info (info@scrantonproducts.com); Web: www.scrantonproducts.com
 - 1. Fabricator: Santana Toilet Partitions.
 - 2. Fabricator: Comtec Toilet Partitions.
 - 3. Fabricator: Capitol Toilet Partitions.
- B. Substitutions: Not permitted.
- C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.02 MATERIAL

- A. Plastic Panels: High density polyethylene (HDPE) suitable for exposed applications, waterproof, non-absorbent, and graffiti-resistant textured surface.
 - 1. Recycled Content; Post Industrial: 25 percent.
- B. Zinc Aluminum Magnesium and Copper Alloy (Zamac): ASTM B 86.
- C. Stainless Steel Castings: ASTM A167, Type 304.
- D. Aluminum: ASTM 6463-T5 alloy.

2.03 SOLID PLASTIC TOILET COMPARTMENTS

- A. Basis of Design: Hiny Hiders Toilet Partitions as manufactured by and supplied by Scranton Products.
 - 1. Style: Floor mounted overhead-braced toilet compartments.
- B. Doors, Panels, and Pilasters: 1 inch (25 mm) thick with all edges rounded to a radius. Mount doors and dividing panels based on height of specified system.
 - 1. Door and Panel Height: 66 inches (1676 mm).
 - 2. Panel Edge: Shiplap.
 - 3. Pilasters: 82 inches (2083 mm) high and fastened to floor.
- C. Pilaster Shoes: 4 inches (76 mm) high type 304, 20 gauge stainless steel. Secured to pilasters with a stainless steel tamper resistant Torx head sex bolt.
- D. Headrail: Heavy-duty extruded 6463-T5 alloy aluminum with anti-grip design. Finish to be clear anodized. Fastened to headrail brackets with stainless steel tamper resistant Torx head sex bolt, and fastened at the top of the pilaster with stainless steel tamper resistant Torx head

screws.

1. Headrail Brackets: 20 gauge stainless steel with satin finish. Secured to the wall with stainless steel tamper resistant Torx head screws.
- E. Wall Brackets:
1. Aluminum Brackets: Heavy-duty aluminum 6463-T5 alloy.
 2. Brackets are fastened to pilasters with stainless steel tamper resistant Torx head screws and fastened to the panels with stainless steel tamper resistant Torx head sex bolts.
 3. Bracket Type: Continuous 68 inches (1727 mm) aluminum.
- F. Door Hardware:
1. Provide zero sight-line hardware.
 2. Continuous Aluminum Hinge:
 - a. Length: 65 inches (1651 mm).
 3. Door Strike/Keeper: Heavy-duty extruded aluminum 6436-T5 alloy with a bright dip anodized finish. Secured to pilasters with stainless steel tamper resistant Torx head sex bolts. Bumper shall be made of extruded black vinyl.
 - a. Style: 71 inches (1803 mm) aluminum.
 4. Provide occupancy indicator.
 5. Doors supplied with one coat hook/bumper and door pull made of chrome plated Zamak.
 6. Equip outswing handicapped doors with second door pull and door stop.

2.04 SOLID PLASTIC PRIVACY SCREENS

- A. Provide plastic privacy screens in urinal and entry toilet room applications as indicated or scheduled.
- B. Panels, and pilasters, if required, 1 inch (25 mm) thick with edges rounded to a radius. Screens to be mounted at 14 inches (356 mm) above the finished floor. Color as selected by Architect from manufacturer's full line of current colors.
 1. Recycled content: Minimum 25 percent.
- C. Screen Type: Wall mounted.
 1. Urinal Screens: 24 inches (610 mm) wide by 42 inches (1067 mm) high.

PART 1 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Examine areas to receive toilet partitions, screens, and shower compartments for correct height and spacing of anchorage/blocking and plumbing fixtures that affect installation of partitions. Report discrepancies to the architect.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install partitions rigid, straight, plumb, and level manor, with plastic laid out as shown on shop drawings.
- C. Clearance at vertical edges of doors shall be uniform top to bottom and shall not exceed 3/8 inch (9.5 mm).
- D. No evidence of cutting, drilling, and/or patching shall be visible on the finished work.

- E. Finished surfaces shall be cleaned after installation and be left free of imperfections.

3.04 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 102113.10

**SECTION 102601
WALL AND CORNER GUARDS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Corner guards.

1.02 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate physical dimensions, features, anchorage details, and rough-in measurements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Wall and Corner Guards:
 - 1. Basis of Design: Inpro; 160BN and Tape-On: www.inprocorp.com.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.02 COMPONENTS

- A. Corner Guards - Flush Mounted:
 - 1. Material: High impact vinylwith full height extruded aluminum retainer.
 - 2. Performance: Resist lateral impact force of 100 lbs at any point without damage or permanent set.
 - 3. Fire Resistance: Where fire rating is specified for the wall in which the guard is mounted, provide assemblies that have been tested in accordance with ASTM E119 for the same rating as the wall.
 - 4. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - 5. Width of Wings: 2 inches.
 - 6. Corner: Square.
 - 7. Length: 48", continuous pieces only.
- B. Corner Guards - Surface Mounted:
 - 1. Material: High impact vinylwith full height extruded aluminum retainer.
 - 2. Performance: Resist lateral impact force of 100 lbs at any point without damage or permanent set.
 - 3. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - 4. Width of Wings: 2 inches.
 - 5. Corner: Square.
 - 6. Color: As selected from manufacturer's standard colors.
 - 7. Length: One piece.

2.03 FABRICATION

- A. Fabricate components with tight joints, corners and seams.
- B. Pre-drill holes for attachment.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to wall framing members only.

3.03 TOLERANCES

- A. Maximum Variation From Required Height: 1/4 inch.
- B. Maximum Variation From Level or Plane For Visible Length: 1/4 inch.

END OF SECTION 102601

**SECTION 102800
TOILET, BATH, AND LAUNDRY ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Commercial toilet accessories.
- B. Commercial shower and bath accessories.
- C. Accessories for toilet rooms and showers.

1.02 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- B. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service 2015a (Reapproved 2019).
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- E. ASTM B456 - Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium 2017.
- F. ASTM F2285 - Standard Consumer Safety Performance Specification for Diaper Changing Tables for Commercial Use 2004, with Editorial Revision (2016).

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.
- C. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Commercial Toilet, Shower, and Bath Accessories:
 - 1. Bradley Corporation; [____]: www.bradleycorp.com.
 - 2. Bobrick Washroom Equipment, Inc.: www.bobrick.com.
 - 3. Substitutions: Section 016000 - Product Requirements.

2.02 MATERIALS

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
 - 1. Fabricate units made of metal sheet of seamless sheets, with flat surfaces.
- B. Stainless Steel Sheet: ASTM A666, Type 304.
- C. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
- D. Adhesive: Two component epoxy type, waterproof.
- E. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

2.03 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.

2.04 COMMERCIAL TOILET ACCESSORIES

- A. Toilet Paper Dispenser: Jumbo roll, surface mounted, for coreless type rolls.
 - 1. Products:
 - a. Georgia-Pacific Professional; Grainger #4DJU8: www.blue-connect.com/#sle.
 - 1) ABS plastic, wall mounted.
 - 2) Color: Translucent smoke.
 - 3) Capacity: 2 - 9" jumbo rolls.
 - (a) Tissue: 1PHJ2 or 1PHJ1
- B. Paper Towel Dispenser, manual operation, surface mounted.
 - 1. Item: high capacity, softPull Roll Towel System as manufactured by Georgia Pacific, Grainger #6HKU8.
 - 2. Capacity: 1,000 foot primary roll plus stub roll.
 - 3. Material: ABS Plastic, translucent smoke.
- C. Waste Receptacle: semi - recessed, stainless steel, seamless lower door for access to container, reinforced panel full height of door, continuously welded bottom pan and seamless exposed flanges.
 - 1. Liner: Removable seamless stainless steel receptacle.
 - 2. Minimum capacity: 2.6 gallons.
- D. Soap Dispenser, surface mounted.
 - 1. Item: Gojo dispenser, FMX, 1250 ML, Grainger #3WU72
 - 2. Color: gray
- E. Grab Bars: Stainless steel, smooth surface.
 - 1. Standard Duty Grab Bars:
 - a. Push/Pull Point Load: 250 pound-force, minimum.
 - b. Dimensions: 1-1/4 inch outside diameter, minimum 0.05 inch wall thickness, exposed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
 - c. Length and Configuration: As indicated on drawings.
- F. Sanitary Napkin Disposal Unit: Stainless steel, surface-mounted, self-closing door, locking bottom panel with full-length stainless steel piano-type hinge, removable receptacle.

2.05 COMMERCIAL SHOWER AND BATH ACCESSORIES

- A. Shower Curtain Rod: Stainless steel tube, 1 inch outside diameter, 0.04 inch wall thickness, satin-finished, with 3 inch outside diameter, minimum 0.04 inch thick satin-finished stainless steel flanges, for installation with exposed fasteners.
- B. Shower Curtain:
 - 1. Material: Opaque vinyl, 0.008 inch thick, matte finish, with antibacterial treatment, flameproof and stain-resistant.
 - 2. Size: 36 by 72 inches, hemmed edges.
 - 3. Grommets: Stainless steel; pierced through top hem on 6 inch centers.
 - 4. Color: White.
 - 5. Shower Curtain Hooks: Chrome-plated or stainless steel spring wire designed for snap closure.
- C. Wall-Mounted Soap Dish: Heavy duty, seamless stainless steel, surface-mounted with drain holes, without grab bar, satin finish; with concealed mechanical fastening suitable for substrate and backplate.
- D. Towel Bar: Stainless steel, 3/4 inch square tubular bar; rectangular brackets, concealed attachment, satin finish.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.

- B. Verify exact location of accessories for installation.
- C. Verify that field measurements are as indicated on drawings.

3.02 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.

3.03 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated. See drawings.

3.04 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 102800

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**SECTION 104400
FIRE PROTECTION SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.

1.02 REFERENCE STANDARDS

- A. FM (AG) - FM Approval Guide current edition.
- B. NFPA 10 - Standard for Portable Fire Extinguishers 2017, with Errata (2018).
- C. UL (DIR) - Online Certifications Directory Current Edition.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.

1.04 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire Extinguishers:
 - 1. Ansul, a Tyco Business; Cleanguard: www.ansul.com/#sle.
 - 2. Kidde, a unit of United Technologies Corp; [____]: www.kidde.com/#sle.
 - 3. Pyro-Chem, a Tyco Business: www.pyrochem.com.
 - 4. Strike First Corporation of America; ABC-Seamless Steel Fire Extinguisher: www.strikefirstusa.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.

2.02 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
 - 1. Provide extinguishers labeled by UL (DIR) or FM (AG) for purpose specified and as indicated.
- B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
 - 1. Class: A:B:C type.
 - 2. Size: 5 pound.
 - 3. Finish: Baked polyester powder coat, [____] color.

2.03 FIRE EXTINGUISHER CABINETS - INTERIOR

- A. Cabinet Configuration: 1 1/2" square trim, Semi-recessed type.
- B. Door: 0.036 inch thick, reinforced for flatness and rigidity; latch. Hinge doors for 180 degree opening with two butt hinge. Provide nylon catch.
- C. Door Glazing: Float glass, clear, 1/8 inch thick, and set in resilient channel glazing gasket.
- D. Door style: Vertical Duo
- E. Finish of Cabinet Exterior Trim and Door: #4 Stainless Steel.
- F. Applied Graphics: Provide applied vinyl lettering as follows: FIRE EXTINGUISHER. Color - black, orientation - vertical.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure rigidly in place.
- C. Place extinguishers in cabinets.

END OF SECTION 104400

**SECTION 111313
LOADING DOCK BUMPERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Loading dock bumpers of reinforced rubber pads with attachment frame.

1.02 RELATED REQUIREMENTS

- A. Section 031000 - Concrete Forming and Accessories: Placement of loading dock bumper frame anchors into concrete.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit data on unit dimensions, method of anchorage, and details of construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Loading Dock Bumpers:
 - 1. Blue Giant Equipment Corporation; []: www.bluegiant.com/#sle.
 - 2. Chalfant Sewing Fabricators, Inc; []: www.chalfantusa.com/#sle.

2.02 COMPONENTS

- A. Loading Dock Bumpers: Fabric reinforced rubber pads, ozone resistant, laminated and compressed in position using two galvanized steel rods with threaded ends, washers, and nuts between 3 inch high by 2-1/2 inch wide by 1/4 inch thick galvanized steel angle end plates.
 - 1. Projection From Wall: 4-1/2 inches.
 - 2. Vertical Height: 10 inches.
 - 3. Width: 24 inches.
 - 4. Profile: Rectangular.
- B. Attachment Hardware: 3/4 inches diameter galvanized bolts with expansion shields.
- C. Touch-up Primer: Zinc rich type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that anchor placement is acceptable.

3.02 INSTALLATION

- A. Install dock bumpers in accordance with manufacturer's instructions.
- B. Set plumb and level.
- C. Secure angled end frames to concrete; refer to Section 031000 for additional information.

END OF SECTION 111313

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**SECTION 123600
COUNTERTOPS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Countertops for architectural cabinet work.

1.02 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- B. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition 2014, with Errata (2016).
- C. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards, U.S. Version 4.0 2021.
- D. ISFA 3-01 - Classification and Standards for Quartz Surfacing Material 2013.
- E. MIA (DSDM) - Dimensional Stone Design Manual, Version VIII 2016.
- F. NEMA LD 3 - High-Pressure Decorative Laminates 2005.
- G. PS 1 - Structural Plywood 2009 (Revised 2019).

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Specimen warranty.
- C. Shop Drawings: Complete details of materials and installation ; combine with shop drawings of cabinets and casework specified in other sections.
- D. Verification Samples: For each finish product specified, minimum size 6 inches square, representing actual product, color, and patterns.
- E. Test Reports: Chemical resistance testing, showing compliance with specified requirements.
- F. Certificate: Submit labels and certificates required by quality assurance and quality control programs.
- G. Maintenance Data: Manufacturer's instructions and recommendations for maintenance and repair of countertop surfaces.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.
- B. Quality Certification:
 - 1. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 2. Provide designated labels on shop drawings as required by certification program.
 - 3. Provide designated labels on installed products as required by certification program.
 - 4. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.06 FIELD CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 COUNTERTOPS

- A. Quality Standard: Premium Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Plastic Laminate Countertops: High-pressure decorative laminate (HPDL) sheet bonded to substrate.
 - 1. Laminate Sheet, Type [____]: NEMA LD 3, Grade HGS, 0.048 inch nominal thickness.
 - a. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - b. Wear Resistance: In addition to specified grade, comply with NEMA LD 3 High Wear Grade requirements for wear resistance.
 - c. Finish: Matte or suede, gloss rating of 5 to 20.
 - 2. Exposed Edge Treatment: Square, substrate built up to minimum 1-1/4 inch thick; covered with matching laminate.
 - 3. Back and End Splashes: Same material, same construction.
- C. Natural Quartz over continuous substrate.
 - 1. Flat Sheet Thickness: 1-1/8" inch, minimum.
 - 2. Natural Quartz Slabs: Complying with ISFA 3-01 and NEMA LD 3; [____] resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Factory fabricate components to the greatest extent practical in sizes and shapes indicated; comply with the MIA Dimension Stone Design Manual.
 - b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - c. Finish on Exposed Surfaces: Polished.
 - d. Color and Pattern: As indicated on drawings.
 - 3. Other Components Thickness: 3/4 inch, minimum.
 - 4. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; mitered edge.
 - 5. Fabricate in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 11 - Countertops, Premium Grade.
- D. Porcelain Slab Countertop
 - 1. Basis of Design: Crossville Porcelain Countertop as manufactured by Crossville, Inc.
 - 2. Thickness: 0.47 inch
 - 3. Finish: matte
 - 4. Color and pattern: As indicated on drawings.
 - 5. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - 6. Fabrication:
 - a. Factory fabricate components to the greatest extent practical in sizes and shapes indicated.
 - b. Cut porcelain countertops accurately to required shapes and dimensions.
 - c. Chamfer exposed edges, including cut-outs, to 2-3 mm radius and polish to match face.
 - d. Fabricate inside corners with not less than 5 mm radius and finish to match face of slab.
 - e. Exposed Countertop Edge Configuration: vertical edge with miter joint to horizontal slab with rounded edges.

2.02 MATERIALS

- A. Wood-Based Components:
 - 1. Wood fabricated from old growth timber is not permitted.
 - 2. Provide sustainably harvested wood, certified or labeled as specified in Section 016000 - Product Requirements.
 - 3. Provide wood harvested within a 500 mile radius of the project site.
- B. Plywood for Supporting Substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch thick; join lengths using metal splines.
- C. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.

2.03 FABRICATION

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
 - 1. Join lengths of tops using best method recommended by manufacturer.
 - 2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
 - 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
 - 1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 - 2. Height: 4 inches, unless otherwise indicated.
- C. Solid Surfacing: Fabricate tops up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.
- D. Wall-Mounted Counters: Provide skirts, aprons, brackets, and braces as indicated on drawings, finished to match.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- B. Attach plastic laminate countertops using screws with minimum penetration into substrate board of 5/8 inch.
- C. Seal joint between back/end splashes and vertical surfaces.

3.04 TOLERANCES

- A. Variation From Horizontal: 1/8 inch in 10 feet, maximum.
- B. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.
- C. Field Joints: 1/8 inch wide, maximum.

3.05 CLEANING

- A. Clean countertops surfaces thoroughly.

3.06 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 123600

**SECTION 133501
CHEMICAL STORAGE BUILDING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Factory fabricated chemical storage building..

1.02 RELATED REQUIREMENTS

- A. Section 033000: Cast In Place Concrete.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate building size, height, anchoring details, interior elevations, building section, electrical connections, ventilation, and fire protection..
- C. Certificate: Certify that products of this section meet or exceed specified requirements.
- D. Delegated Design Documents: Drawings and calculations professional engineer registered in the State of Florida.
- E. Manufacturer's qualification statement.
- F. Testing agency's qualification statement.
- G. Specimen warranty.

1.04 QUALITY ASSURANCE

- A. Designer Qualifications: Perform design under direct supervision of Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
 - 1. Provide all necessary local jurisdiction approvals for manufactured / fabricated building as required by State of Florida statutes and codes.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least 10 years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
- D. Documents at Project Site: Maintain at project site one copy of manufacturer's instructions, erection drawings, and shop drawings.

1.05 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 2-year manufacturer warranty for complete building assembly. Complete forms in Owner's name and register with manufacturer.
- C. Extended Correction Period: Correct defective work within 2-year period commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

2.02 COMPONENTS

- A. Description:
 - 1. Exterior Dimensions: 16'-0" long x 5'-6" deep x 9'-5" high.
 - 2. Interior Dimensions: 14'-2" long x 4'-2" deep x 7'-6" high.
 - 3. Building Weight: 10,050 lbs
 - 4. Floor Load: 205 psf
 - 5. Wind Load: Comply with Florida Building Code.
 - 6. Sump Capacity: 218 gallons.
- B. Design Criteria:

1. WALL STRUCTURAL FRAMEWORK: Two hour bi-directional fire rated, weatherproof construction that meets or exceeds UL 263 and ASTM E-119. Fabricated from 14ga galvanized steel proprietary studs placed 24-inch on center. Building perimeter shall have 6"x4"x1/8" steel tubing minimum below and above wall studs. The corner studs and door frame opening studs shall be minimum 4"x3"x1/8". Framework connected by welding. Construction consists of multiple layers of UL Listed gypsum wallboard encased between Galvanneal steel sheets on interior and exterior faces for maximum durability. Gypsum wall board layers are offset with overlapping joints. Mineral wool installed in the wall cavity with a R-12 minimum rating..
2. ROOF SYSTEM: One (1) hour Per IBC Section 722, fire rated Class A flame spread rating. Wind uplift exceeds UL I-60 and is constructed of 1 hour fire rated, weatherproof construction. Exterior roof sheets are continuously welded to roof supports at each seam. Roof Structural System is fabricated from 4"X2"X1/8" structural tubing on 24" centers, welded to roof supports at each seam. 12 ga. HRS steel roof with multiple layers of UL Listed fire resistant gypsum wall board lined on the interior with galvanealed steel sheets on interior. Assembly meets or exceeds UL 263 and ASTM-E119. Roof is sloped to facilitate runoff and door(s) are equipped with rain shields on exterior.
3. FLOOR SYSTEM: Grating and Leak Proof Spill-Containment Sump Assembly consisting of 1" deep welded galvanized steel floor grating over 6" deep leak proof secondary containment sump. Galvanized steel floor grating fabricated from welded steel grating with 1" tall x 3/16" thick bearing bars at 1" on center and crossbars at 4" on center. Sump floor is fabricated utilizing continuously welded 10 gauge steel sheets for maximum spill containment. Acrylic alkyd enamel coating is applied to secondary containment sump. Floor System is fabricated to comply with NAAMM MBG 531, "Metal Bar Grating Manual for Steel, Stainless Steel, and Aluminum Gratings and Stair Treads."
4. BUILDING BASE: Open channel construction, underside coated with corothan I-Coal Tar for maximum corrosion resistance. Forklift pockets and hold-down brackets for ease of off-loading and relocation. The building base is constructed in a manner to ensure the fork lifting, loading, transporting, offloading, and relocation do not affect this chemical storage building. This is to ensure the door openings remain square after lifting the building multiple times with a crane or fork trucks. The building base assembly shall consist of the following materials: 6 x 4 x 3/16" rectangular tubing, Hold Down Brackets welded to building are 1/2" thick plate steel angles, Floor Channel C 4x5.4, Floor Channel C6x8.2, and 4 x 2 x 1/8" rectangular tubing.
5. STATIC GROUNDING SYSTEM: Three (3) Interior grounding lugs, one (1) exterior static grounding connection and one (1) 10-foot long 5/8" diameter copper-clad steel grounding rod, and grounding lugs.
6. GRAVITY AIR FLOW VENTS: UL listed with minimum 1-1/2 hour rated fire dampers with UL listed 165 degree fusible links. Dampers include louvers and screens to provide airflow and have a galvanized steel frame and curtain type galvanized steel blades.
7. BUILDING FINISH: After an extensive cleaning process, the interior and exterior surfaces are protected with a high solids alkyd universal metal primer (primer) and a high solid acrylic alkyd enamel top coat providing proven resistance to exterior abrasion, corrosion, UV resistance and exceptional durability.
8. SIGNAGE: Permanent D.O.T. metal flip placard with rust proof aluminum holder and stainless steel clips on each building. One (1) pressure sensitive NFPA 704 Hazard Rating sign.
9. COLOR, POLYSILOXANE, BL BONE
 - a. HIGH SOLIDS, ISOCYANATE FREE POLY SILOXANE EPOXY COATING COMBINES THE PROPERTIES OF HIGH PERFORMANCE EPOXY AND POLYURETHANE IN ONE COAT.
10. DOOR 36 X 80 3HR RIGHT STD
 - a. SINGLE DOOR, 36" WIDE X 80" TALL, 3 HOUR FIRE RATED UL CLASSIFIED & LABELED, 3 HOUR FIRE-RATED 36"W X 80"H SINGLE DOOR. EQUIPPED WITH A UL LISTED DOOR CLOSER AND A UL LISTED EXTERIOR KEYED LOCK. DOOR SERVES AS A ENTRANCE AND EXIT DOOR.

11. FL2 PART WALL 5-7 2HR STD
 - a. INTERIOR SEPERATION WALL FOR FL2 MODELS (5' - 7' NOMINAL WIDTH). 2HR-FIRERATED WALL CONSTRUCTION, SEPERATION WALL EXTENDS FROM SUMP BASE TO CEILING.
12. PASSIVE AIR INLET W/VD
 - a. AIR INLET VENT TO PROVIDE NATURAL VENTILATION AND IS EQUIPPED WITH A FUSIBLE LINK FIRE DAMPER (3 HOUR) TO CLOSE IN THE EVENT OF A FIRE. VENT IS EQUIPPED WITH AN EXTERIOR LOUVER AND AN INTERIOR SCREEN TO PREVENT BIRD OR ANIMAL ENTRY. AN ADJUSTABLE REGISTER IS PROVIDED FOR MANUAL CONTROL OF AIR FLOW.
13. SHELVING 2 TIER SYSTEM
 - a. LINEAR FEET OF TWO TIERS OF SUMP SHELVING: ADJUSTABLE 16" LEAKPROOF STEEL SHELVING FORMED AND WELDED FROM HEAVY GAUGE STEEL WITH A 2" LIP AROUND THE ENTIRE SHELF. SHELVING LENGTHS ARE APPROXIMATE AND MAY VARY DUE TO SPACE LIMITATIONS. TOTAL PRICE IS CALCULATED FROM QUANTITY OF LINEAR FEET QUOTED. WEIGHT CAPACITY: 75 LBS. PER LINEAR FOOT. 8 LFT OF SHELVING PER ROOM.
14. FG T -BAR GRAT PSF REPL
 - a. PULTRUDED T-BAR FIBERGLASS FLOOR GRATING MADE WITH FIRE-RETARDANT VINYLESTER RESIN. IT IS CORRISION AND ULTRAVIOLET (UV) RESISTANT WITH A LOW FLAME SPREAD OF 25 OR LESS. 1-1/2" HEIGHT, 38% OPEN AREA FOR EASE OF FLOW SPILLS INTO SUMP. CORROSIVES ROOM ONLY.
15. DRY CHEM 45LB
 - a. UL, ULC LISTED AND FM APPROVED PRE-ENGINEERED DRY CHEMICAL FIRE SUPPRESSION SYSTEM FOR CLASS A,B AND C FIRES. EQUIPPED WITH MEANS FOR REMOTE ANNUNCIATION. SYSTEM INCLUDES FUSIBLE LINK DETECTION FOR AUTOMATIC ACTUATION, MANUAL PULL STATION, AND NOZZLE(S) FOR TOTAL FLOODING APPLICATION. AGENT STORAGE LOCATED ON BUILDING EXTERIOR IN WEATHERPROOF ENCLOSURE. AUDIBLE ALARM INCLUDED WITH SYSTEM. PROVIDE SYSTEMS COMPLETE WITH FULL TANK OF SUPPRESSANT.
 - 1) **NOTE - GENERAL CONTRACTOR RESPONSIBLE TO ARRANGE FOR SYSTEM TO BE ARMED BY AN INDEPENDENT, LICENSED TECHNICIAN AND ANY RESULTING TESTS OR OTHER MAINTENANCE.
16. RAMP ADJUSTABLE 48 X 96 HD
 - a. ACCESS RAMP (48"W X 96"L) ADJUSTABLE, FABRICATED FROM 1/8" DIAMOND PLATE STEEL. COLOR: SAFETY YELLOW. RATED FOR 100 LBS PER SQ FT AND 1,500 LBS POINT LOAD.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.
- B. General Contractor shall be responsible for securing any required third party or local approvals necessary.
- C. General Contractor shall be responsible for arranging transportation of building, offloading, anchoring, arming dry chemical fire suppression, and electrical / water connections and/or permits.

3.02 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Nonconforming Work: shall be corrected in a timely manner at the contractors expense.

3.03 SYSTEM STARTUP

- A. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.

3.04 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals for additional submittals.
- B. Demonstrate proper operation of equipment to Owner's designated representative.

END OF SECTION 133501

**SECTION 142400
HYDRAULIC ELEVATORS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Complete hydraulic elevator systems.
 - 1. Passenger type.
- B. Elevator Maintenance Contract.

1.02 RELATED REQUIREMENTS

- A. Section 042000 - Unit Masonry: Masonry hoistway enclosure; building-in and grouting hoistway door frames.
- B. Section 051200 - Structural Steel Framing: Includes overhead hoist beams.
- C. Section 078400 - Firestopping: Fire rated sealant in hoistway.
- D. Section 096500 - Resilient Flooring: Floor finish in car.
- E. Section 211300 - Fire-Suppression Sprinkler Systems: Sprinkler heads in hoistway.
- F. Section 260533.13 - Conduit for Electrical Systems:
- G. Section 260583 - Wiring Connections:
- H. Section 284600 - Fire Detection and Alarm:

1.03 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials Current Edition.
- B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- C. AISC 360 - Specification for Structural Steel Buildings 2016 (Revised 2021).
- D. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test 2015.
- E. ASME A17.1 - Safety Code for Elevators and Escalators 2019.
- F. ASME A17.2 - Guide for Inspection of Elevators, Escalators, and Moving Walks 2020.
- G. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- H. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2020.
- I. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2013.
- J. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass 2018.
- K. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020.
- L. ITS (DIR) - Directory of Listed Products current edition.
- M. NEMA MG 1 - Motors and Generators 2018.
- N. NFPA 13 - Standard for the Installation of Sprinkler Systems Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- O. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- P. NFPA 80 - Standard for Fire Doors and Other Opening Protectives 2019.
- Q. PS 1 - Structural Plywood 2009 (Revised 2019).
- R. UL (DIR) - Online Certifications Directory Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate work with other installers to provide conduits necessary for installation of wiring including but not limited to:
 - a. Elevator equipment devices remote from elevator machine room or hoistway.
 - b. Elevator pit for lighting and sump pump.
 - 2. Coordinate work with other installers for equipment provisions necessary for proper elevator operation, including but not limited to, the following:
 - a. Automatic transfer switches with auxiliary contacts for emergency power transfer status indication.
 - b. Shunt trip devices for automatic disconnection of elevator power prior to fire suppression system activation.
 - c. Overcurrent protection devices selected to achieve required selective coordination.
- B. Preinstallation Meeting: Convene meeting at least one week prior to start of this work.
 - 1. Review schedule of installation, proper procedures and conditions, and coordination with related work.
- C. Construction Use of Elevator: Provide designated elevator for transport of construction personnel and materials in compliance with ASME A17.1.
 - 1. Enclose car with protective plywood on floor, walls, and ceiling.
 - 2. Provide temporary lighting.
 - 3. Provide control panel with manual and emergency operation.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit data on following items:
 - 1. Signal and operating fixtures, operating panels, and indicators.
 - 2. Car design, dimensions, layout, and components.
 - 3. Car and hoistway door and frame details.
 - 4. Electrical characteristics and connection requirements.
- C. Shop Drawings: Include appropriate plans, elevations, sections, diagrams, and details on following items:
 - 1. Elevator Equipment and Machines: Size and location of driving machines, power units, controllers, governors, and other components.
 - 2. Hoistway Components: Size and location of car guide rails, buffers, jack unit and other components.
 - 3. Rail bracket spacing; maximum loads imposed on guide rails requiring load transfer to building structural framing.
 - 4. Clearances and over-travel of car.
 - 5. Locations in hoistway and machine room of traveling cables and connections for car lighting and telephone.
 - 6. Location and sizes of hoistway and car doors and frames.
 - 7. Electrical characteristics and connection requirements.
 - 8. Indicate arrangement of elevator equipment and allow for clear passage of equipment through access openings.
- D. Samples: Submit samples illustrating car interior finishes, car and hoistway door and frame finishes, and handrail material and finish in the form of cut sheets or finish color selection brochures.
- E. Testing Agency's Qualification Statement.
- F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- G. Initial Maintenance Contract.
- H. Maintenance Contract: Submit proposal to Owner for standard one year continuing maintenance contract agreement in accordance with ASME A17.1 and requirements as

indicated, starting on date initial maintenance contract is scheduled to expire.

1. Indicate in proposal the services, obligations, conditions, and terms for agreement period and for renewal options.
- I. Operation and Maintenance Data:
 1. Parts catalog with complete list of equipment replacement parts; identify each entry with equipment description and identifying code.
 2. Operation and maintenance manual.
 3. Schematic drawings of equipment and hydraulic piping, and wiring diagrams of installed electrical equipment with list of corresponding symbols to identify markings on machine room and hoistway apparatus.

1.06 QUALITY ASSURANCE

- A. Maintain one copy of each quality standard document on site.
- B. Designer Qualifications: Design guide rails, brackets, anchors, and machine anchors under direct supervision of a licensed Professional Structural Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.
- D. Installer Qualifications: Trained personnel and supervisor on staff of elevator equipment manufacturer.
- E. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of type specified in this section.
- F. Products Requiring Fire Resistance Rating: Listed and classified by ITS (DIR), UL (DIR), or testing agency acceptable to authorities having jurisdiction.
- G. Products Requiring Electrical Connection: Listed and classified by UL (DIR) or testing agency acceptable to authorities having jurisdiction as suitable for the purpose indicated in construction documents.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide manufacturer's warranty for elevator operating equipment and devices for one year from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design - Hydraulic Elevators: ThyssenKrupp Elevator; Endura MRL 5000H.
- B. Other Acceptable Manufacturers - Hydraulic Elevators:
 1. Otis Elevator Company; [____]: www.otis.com/#sle.
 2. Schindler Elevator Corporation; [____]: www.schindler.com/#sle.
- C. Substitutions: See Section 016000 - Product Requirements.
- D. Products other than Basis of Design are subject to compliance with specified requirements and prior approval of Architect. By using products other than Basis of Design, the Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
- E. Source Limitations: Provide elevator and associated equipment and components produced by the same manufacturer as the other elevator equipment used for this project and obtained from a single supplier .

2.02 HYDRAULIC ELEVATORS

- A. Hydraulic Passenger Elevator, No. 1:
 1. Hydraulic Elevator Equipment:
 - a. Holeless hydraulic with cylinder mounted within hoistway.
 2. Drive System:

- a. Variable voltage variable frequency (VVVF) to modulate motor speed.
3. Operation Control Type:
4. Interior Car Height: 96 inch.
5. Electrical Power: 480 volts; alternating current (AC); three phase; 60 Hz.
6. Rated Net Capacity: 5,000 lbs.
7. Rated Speed: 150 ft per minute.
8. Hoistway size: 11'-4 3/4" wide by 8'-2" Deep
9. Interior Cab Clear Dimensions: 8'-5 1/2" wide by 5'-8" deep.
10. Elevator Pit Depth: 48 inch.
11. Travel Distance: 18'-0".
12. Number of Stops: 2.
13. Number of Openings: 2 Front; 2 Rear.

2.03 COMPONENTS

- A. Elevator Equipment:
 1. Motors, Hydraulic Equipment, Controllers, Controls, Buttons, Wiring, Devices, and Indicators: Comply with NFPA 70. Refer to Section 260583
 2. Guide Rails, Cables, Buffers, Attachment Brackets and Anchors: Design criteria for components includes safety factors in accordance with applicable requirements of Elevator Code, ASME A17.1.
 3. Buffers:
 - a. Spring type for elevators with speed less than or equal to 200 feet per minute.
 4. Lubrication Equipment:
 - a. Provide grease fittings for periodic lubrication of bearings.
 - b. Grease Cups: Automatic feed type.
 - c. Lubrication Points: Visible and easily accessible.
- B. Electrical Equipment:
 1. Motors: NEMA MG 1.
 2. Boxes, Conduit, Wiring, and Devices: As required by NFPA 70. Refer to Sections 260533.13 and 260583.
 3. Spare Conductors: Provide ten percent in extra conductors and two pairs of shielded audio cables in traveling cables.
 4. Include wiring and connections to elevator devices remote from hoistway and between elevator machine room. Provide additional components and wiring to suit machine room layout. Refer to Section 260583.

2.04 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1, applicable local codes, and authorities having jurisdiction (AHJ).
- B. Accessibility Requirements: Comply with ADA / Florida Accessibility Code Standards.
- C. Perform structural steel design, fabrication, and installation in accordance with AISC 360.
- D. Perform welding of steel in accordance with AWS D1.1/D1.1M.
- E. Fabricate and install door and frame assemblies in accordance with NFPA 80 and in compliance with requirements of authorities having jurisdiction.
- F. Perform electrical work in accordance with NFPA 70.
- G. Comply with venting or pressurization of hoistway design in accordance with HVAC system requirements and authorities having jurisdiction (AHJ).
- H. Comply with fire protection sprinkler system of hoistway design in accordance with NFPA 13 requirements and authorities having jurisdiction (AHJ). Refer to Section 211300.

2.05 OPERATION CONTROLS

- A. Elevator Controls: Provide landing operating panels and landing indicator panels.

1. Landing Operating Panels: Metallic type, one for originating "Up" and one for originating "Down" calls, one button only at terminating landings; with illuminating indicators.
 2. Landing Indicator Panels: Illuminating.
 3. Comply with ADA Standards for elevator controls.
 4. Style: Basis of Design: TK - Signa4.
- B. Interconnect elevator control system with building security and fire alarm systems.
- C. Door Operation Controls:
1. Program door control to open doors automatically when car arrives at floor landing.
 2. Render "Door Close" button inoperative when car is standing at dispatch landing with doors open.
 3. Door Safety Devices: Moveable, retractable safety edges, quiet in operation; equipped with photo-electric light rays.
- D. Lobby Monitoring Panel:
1. Mount panel in console as indicated on drawings.
 2. Coordinate size and style of panel with console manufacturer.
 3. Etch face plate markings in panel, and fill with paint of contrasting color.
 4. Include direction indicator displaying landing "Up" and "Down" calls registered at each landing floor.
 5. Include position and motion display for direction of travel of each elevator. Display appropriate graphic characters on non-glare screen. Indicate position of cars at rest and in motion.
 6. Include "Firefighter's Service Switch" that manually recalls each elevator to main floor.
- E. Provide "Firefighter's Emergency Operation" in accordance with ASME A17.1, applicable building codes, and authorities having jurisdiction (AHJ).
1. Designated Landing: Fire Command Center - Parking Level 1.

2.06 OPERATION CONTROL TYPE

- A. Single Automatic (Push Button) Operation Control: Applies to car in single elevator shaft.
1. Refer to description provided in ASME A17.1.
 2. Set system operation so that momentary pressure of landing button dispatches car from other landing to that landing.
 3. Allow call registered by momentary pressure of landing button at any time to remain registered until car stops in response to that landing call.
 4. If elevator car door is not opened within predetermined period of time after car has stopped at terminal landing allow car to respond to call registered from other landing.

2.07 EMERGENCY POWER

- A. Elevator Emergency Power Supply: Supplied by battery backup; provide elevator system components as required for emergency power characteristics.
- B. Emergency Lighting: Comply with ASME A17.1 elevator lighting requirements.
- C. Provide operational control circuitry for adapting the change from normal to emergency power.

2.08 MATERIALS

- A. Stainless Steel Sheet: ASTM A666, Type 304; No. 4 Brushed finish unless otherwise indicated.
- B. Extruded Aluminum: ASTM B221 (ASTM B221M), natural anodized finish unless otherwise indicated.
- C. Tempered Glass: 3/8 inch minimum thickness, fully tempered in compliance with ASME A17.1, 16 CFR 1201, ANSI Z97.1, and ASTM C1048 tempered glass requirements.

2.09 CAR AND HOISTWAY ENTRANCES

- A. Elevator, No. 1:
1. Car and Hoistway Entrances, Each Elevator Floor Lobby:
 - a. Framed Opening Finish and Material: Brushed stainless steel.

- b. Car Door Material: To match hoistway entrance doors, with rigid sandwich panel construction.
- c. Hoistway Door Material: To match cab entrance doors, with rigid sandwich panel construction.
- d. Door Operation: Side opening, two speed.
- e. Door Width: 54 inch.
- f. Door Height: 84 inch.
- g. Sills: Extruded aluminum.

2.10 CAR EQUIPMENT AND MATERIALS

- A. Elevator Car, No. 1:
 - 1. Car Operating Panel: Provide main and auxiliary; flush-mounted applied face plate, with illuminated call buttons corresponding to floors served with "Door Open/Door Close" buttons, "Door Open" button, "Door Close" button, and alarm button.
 - a. Panel Material: Integral with front return; one per car.
 - b. Car Floor Position Indicator: Above door with illuminating position indicators.
 - c. Locate alarm button where it is unlikely to be accidentally actuated; not more than 54 inch above car finished floor.
 - 2. Flooring: Resilient vinyl plank.
 - 3. Front Return Panel: Match material of car door.
 - 4. Door Wall: Stainless steel.
 - 5. Side Walls: Plastic laminate on Stainless Steel.
 - 6. Rear Wall: Plastic laminate on Stainless Steel.
 - 7. Hand Rail: Aluminum, at all three sides. Provide open clearance space 1-1/2 inch (38 mm) wide to face of wall.
 - a. Round, Metal Tube: 1-1/2 inch diameter.
 - b. Stainless Steel Finish: No. 4 Brushed.
 - 8. Ceiling:
 - a. Canopy Ceiling: Style TK - Metal pan with downlights.
 - b. Panel Finish: No. 4 Brushed stainless steel.
 - c. Lighting: LED.
 - 9. Provide emergency access panel for egress from car at ceiling.
- B. Car Accessories:
 - 1. Certificate Frame: Stainless steel frame glazed with tempered glass, and attached with tamper-proof screws.
 - 2. Protective Pads: Canvas cover, padded with impact-resistant fill material, sewn with piping edges; fire resistant in compliance with ASME A17.1; brass grommets for supports, covering side and rear walls and front return, with cut-out for control panel; provide one set for each elevator.
 - a. Color: Grey.
 - b. Provide at least 4 inch clearance from bottom of pad to finished floor.
 - c. Pad Supports: Stainless steel studs, and mounted from ceiling frame.

2.11 HOISTWAY ENTRANCES

- A. Hoistway Entrances:
 - 1. Framed Opening Material and Finish: Brushed stainless steel.
 - 2. Door Material and Finish: Brushed stainless steel.
 - 3. Sills: Extruded aluminum.
- B. Car Doors:
 - 1. Car Door Material and Finish: Brushed stainless steel.
 - 2. Sills: Extruded aluminum.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting this work.

- B. Verify that hoistway, pit, machine room, and [] are ready for work of this section.
- C. Verify hoistway shaft and openings are of correct size and within tolerance.
- D. Verify location and size of machine foundation and position of machine foundation bolts.
- E. Verify that electrical power is available and of correct characteristics.

3.02 PREPARATION

- A. Arrange for temporary electrical power for installation work and testing of elevator components, and comply with requirements of Section 015000 - Temporary Facilities and Controls.
- B. Maintain elevator pit excavation free of water.

3.03 INSTALLATION

- A. Coordinate this work with installation of hoistway wall construction.
- B. Install system components, and connect equipment to building utilities.
- C. Provide conduit, electrical boxes, wiring, and accessories. Refer to Sections 260533.13 and 260583.
- D. Install hydraulic piping between cylinder and pump unit.
- E. Mount machines, motors, and pumps on vibration and acoustic isolators, on bed plate and concrete pad.
 - 1. Securely fasten to building supports.
 - 2. Prevent lateral displacement.
- F. Install hoistway, elevator equipment, and components in accordance with approved shop drawings.
- G. Install guide rails to allow for thermal expansion and contraction movement of guide rails.
- H. Accurately machine and align guide rails, forming smooth joints with machined splice plates.
- I. Install hoistway door sills, frames, and headers in hoistway walls; grout sills in place, set hoistway floor entrances in alignment with car openings, and align plumb with hoistway.
- J. Structural Metal Surfaces: Clean surfaces of rust, oil or grease; wipe clean with solvent; prime two coats.
- K. Wood Surfaces not Exposed to Public View: Finish with one coat primer; one coat enamel.
- L. Adjust equipment for smooth and quiet operation.

3.04 TOLERANCES

- A. Guide Rail Alignment: Plumb and parallel to each other in accordance with ASME A17.1 and ASME A17.2.
- B. Car Movement on Aligned Guide Rails: Smooth movement, without any objectionable lateral or oscillating movement or vibration.

3.05 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Testing and inspection by regulatory agencies will be performed at their discretion.
 - 1. Schedule tests with agencies and notify Owner and Architect.
 - 2. Obtain permits as required to perform tests.
 - 3. Document regulatory agency tests and inspections in accordance with requirements.
 - 4. Perform tests required by regulatory agencies.
 - 5. Furnish test and approval certificates issued by authorities having jurisdiction.

3.06 ADJUSTING

- A. Adjust for smooth acceleration and deceleration of car to minimize passenger discomfort.
- B. Adjust with automatic floor leveling feature at each floor landing to reach 1/4 inch maximum from flush with sill.

3.07 CLEANING

- A. Remove protective coverings from finished surfaces.
- B. Clean surfaces and components in accordance with manufacturers written instructions.

3.08 CLOSEOUT ACTIVITIES

- A. Demonstrate proper operation of equipment to Owner's designated representative.
- B. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Briefly describe function, operation, cleaning and maintenance of each component.
- C. Training: Train Owner's personnel on cleaning and operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.

3.09 PROTECTION

- A. Do not permit construction traffic within car after cleaning.
- B. Protect installed products until Date of Substantial Completion.
- C. Touch-up, repair, or replace damaged products and materials prior to Date of Substantial Completion.

3.10 MAINTENANCE

- A. Provide Initial Maintenance Contract of elevator system and components in accordance with ASME A17.1 and requirements as indicated for 3 months from Date of Substantial Completion.
- B. Perform maintenance contract services using competent and qualified personnel under the supervision and direct employ of the elevator manufacturer or original installer.
- C. Maintenance contract services shall not be assigned or transferred to any agent or other entity without prior written consent of Owner.
- D. Include systematic examination, adjustment, and lubrication of elevator equipment.
- E. Maintain and repair or replace parts, whenever required, using parts produced by original equipment manufacturer.
- F. Perform work without removing cars from use during peak traffic periods.
- G. Provide emergency call back service for 24 hours a day/7 days a week throughout period of this maintenance contract.
- H. Maintain an adequate stock of parts for replacement or emergency purposes, and have personnel available to ensure the fulfillment of this maintenance contract without unreasonable loss of time.

END OF SECTION 142400

SECTION 200000
GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.02 DESCRIPTION

- A. Intent of Drawings and Specifications is to obtain complete systems, tested, adjusted, and ready for operation.
- B. Except as otherwise defined in greater detail, the terms "provide", "furnish" and "install" as used in Division 20, 21, 22 and 23 Contract Documents shall have the following meanings:
 - 1. "Provide" or "provided" shall mean "furnish and install".
 - 2. "Furnish" or "furnished" does not include installation.
 - 3. "Install" or "installed" does not include furnishing.
- C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.
- D. Check, verify and coordinate work with Drawings and Specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.
- E. Information given herein and on Drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions.
- F. Where Architectural features govern location of work, refer to Architectural Drawings.
- G. Contractor may install additional piping, fittings and valves, not shown on drawings, for testing purposes or for convenience of installation. Where such materials are installed, they shall comply with Specifications and shall be sized to be compatible with system design. Remove such installed materials when they interfere with design conditions or as directed by Architect.

1.03 RELATED WORK

- A. Utility Services:
 - 1. Determine utility connection requirements and include in Base Bid all costs to Owner for utility service.
 - 2. Include costs for temporary service, temporary routing of piping or any other requirements of a temporary nature associated with utility service.
- B. Temporary Services: Refer to Section 01500 (Temporary Facilities and Controls).
- C. Concrete Work:
 - 1. Refer to Section 03300 (Cast-In-Place Concrete).
 - 2. Provide anchor bolts, metal shapes and templates required to be cast in concrete or used to form concrete for support of mechanical equipment.
- D. Painting:
 - 1. Refer to Sections 09911 (Painting) and 09912 (Interior Painting).
 - 2. Equipment:
 - a. Furnish equipment with factory applied prime and finish coats unless otherwise specified.
 - b. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Architect.
 - c. Furnish one can of touch up paint for each factory-applied coat of product.
 - 3. Piping:
 - a. Paint the following piping including fittings, valve bodies, and supports.
 - 1) Exposed cast iron and steel piping located outside building and inside the mechanical rooms.
 - 2) Exception: galvanized piping and supports

- 3) Exposed piping located in spaces with finished ceilings
- b. Paint Colors:
 - 1) Exposed piping within finished spaces and mechanical rooms: color selected by the architect
 - 2) Exterior natural gas: yellow
 - 3) Exterior fire protection: red

1.04 REQUIREMENTS OF REGULATORY AGENCIES

- A. Rules and regulations of Federal, State and Local Authorities and utility companies, in force at time of execution of Contract shall become part of this specification.

1.05 REFERENCE STANDARDS

- A. Agencies or publications referenced herein refer to the following:
 1. AGA American Gas Association
 2. AHRI Air-Conditioning, Heating and Refrigeration Institute
 3. AMCA Air Movement and Control Association
 4. ANSI American National Standards Institute
 5. ASHRAE American Society of Heating Refrigerating and Air Conditioning Engineers
 6. ASPE American Society of Plumbing Engineers
 7. ASSE American Society of Sanitary Engineering
 8. AWS American Welding Society
 9. AWWA American Water Works Association
 10. ASME American Society of Mechanical Engineers
 11. ASTM American Society for Testing and Materials
 12. CDA Copper Development Association
 13. CGA Compressed Gas Association
 14. CISPI Cast Iron Soil Pipe Institute
 15. DIPRA Ductile Iron Pipe Research Association
 16. EPA United States Environmental Protection Agency
 17. FMG FM Global
 18. FS Federal Specifications
 19. IAPMO International Association of Plumbing and Mechanical Officials
 20. ICC International Code Council
 21. IEEE Institute of Electrical and Electronics Engineers
 22. ISO International Organization for Standardization
 23. MCA Mechanical Contractors Association
 24. MSS Manufacturers Standardization Society
 25. NEC National Electrical Code
 26. NEMA National Electrical Manufacturers Association
 27. NFPA National Fire Protection Association
 28. NIST National Institute of Standards & Technology
 29. NSF National Sanitation Foundation
 30. NSPI National Spa and Pool Institute
 31. OSHA Occupational Safety and Health Administration
 32. PDI Plumbing and Drainage Institute
 33. PPI Plastic Pipe Institute
 34. SMACNA Sheet Metal and Air Conditioning Contractors National Association
 35. UL Underwriters Laboratories, Inc.
 36. US DOT CFR United States Dept. of Transportation, Code of Federal Regulations
 37. WCF Water Conditioning Foundation
- B. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.06 SUBMITTALS

- A. Shop Drawings (Product Data):
 - 1. Refer to Section 01330 (Submittal Procedures).
 - 2. Include composite wiring diagrams for electrically powered equipment and devices.
 - 3. Do not submit "Coordination Drawings", which are normally prepared by Contractor to coordinate work among various trades and to facilitate installation, work unless specifically requested in technical sections. These types of drawings typically include dimensioned piping, ductwork or electrical raceway layouts.
 - 4. Unless specifically requested in Division 20, 21, 22 or 23 technical sections, submittals of coordination drawings will be returned without review.
- B. Certificates and Inspections: Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.
- C. Operation and Maintenance Manuals:
 - 1. Refer to Section 01782 (Operation and Maintenance Data).
 - 2. Additional Requirements:
 - a. Wiring diagrams
 - b. Startup and shutdown procedures
 - c. Composite electrical diagrams
 - d. Flow diagrams
 - e. Lubrication instructions
 - f. Factory and field test records (Refer to Test and Balancing in Part 3 of this Section.)
 - g. Air and water balance reports
 - h. Valve identification charts as specified in Section 20 0553 (Mechanical System Identification)
 - i. Access panel identification charts as specified in Section 20 0553 (Mechanical System Identification)
 - j. Additional information, diagrams or explanations as designated under respective equipment or systems specification sections.
 - 3. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
- D. Record Documents: Refer to Section 01781 (Project Record Documents).

1.07 JOB CONDITIONS

- A. Building Access: Arrange for necessary openings in building to allow for admittance of all apparatus.
- B. Electrical Coordination:
 - 1. Refer to Section 20 0513 (Motors)
 - 2. Provide the following items as specified under their respective Division(s) (Division 20, 21, 22 and 23):
 - a. Motors
 - b. Electrically powered equipment
 - c. Electrically controlled equipment
 - d. Starters, where specified
 - e. Variable frequency drives, where specified
 - f. Control devices, where specified
 - g. Temperature Control wiring
 - h. Wiring diagrams to electrical installer for apparatus indicating external connection and internal controls.
 - i. Disconnect devices furnished with equipment:
 - 1) Devices shall have an interrupting rating not less than that of the upstream overcurrent device as shown on electrical drawings.
 - 2) Provide equipment electrical connection points labeled with listed electrical short circuit current rating (sccr). Sccr shall not be less than interrupting rating of

upstream overcurrent device as shown on electrical drawings. SCCR shall be marked on equipment control enclosure in accordance with UL508, or other acceptable, accredited third-party testing agency standards.

3. Refer to Division 26 for the following devices required for control of motors or electrical equipment, unless noted otherwise.
 - a. Starters
 - b. Disconnect devices
 - c. Control devices:
 - 1) Pushbuttons
 - 2) Pilot lights
 - 3) Contacts
 - d. Conduit, boxes and wiring for power wiring.
 - e. Conduit, boxes and wiring for control wiring, except temperature control wiring.
 4. Notify the electrical installer of any change in size, rating, voltage, or means of control of any motor or other electrical equipment.
- C. Cutting and Patching:
1. Refer to Division 01 (General Requirements).
 2. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
- D. Housekeeping and Cleanup: Refer to Section 01524 (Construction Waste Management).

1.08 WARRANTY

- A. Refer to Division 01 (General Requirements).
- B. Warranty that systems will operate without objectionable noise, vibration and uncontrolled expansion.

PART 2 - PRODUCTS

2.01 PRODUCT SUBSTITUTIONS

- A. Refer to Division 01 (General Requirements).

PART 3 - EXECUTION

3.01 GENERAL

- A. Verify elevations and dimensions prior to installation of materials.

3.02 DELIVERY, STORAGE, HANDLING, AND PROTECTION

- A. Deliver products to the site under provisions of Division 01.
- B. Store and protect products under provisions of Division 01.
- C. Store in clean, dry space.
- D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.
- E. Handle in accordance with manufacturer's written instructions.
- F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.
- G. Protect openings in equipment until connected to system to prevent entry of foreign materials.

3.03 FLOOR, WALL, ROOF AND CEILING OPENINGS

- A. Coordinate location of openings, chases, furred spaces, etc., with appropriate installers. Provide sleeves and inserts that are to be built into structure during progress of construction.
- B. Remove temporary sleeves, if used to form openings, prior to installation of permanent materials. Utilize minimum 24 gauge galvanized sheet metal for permanent sleeves unless otherwise noted.

- C. Submit product data and installation details for penetrations of building structure. Include schedule indicating penetrating materials (metal pipe, plastic pipe, conduit, etc.), sizes of each, opening sizes and sealant products intended for use.
- D. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Section 20 0573 (Mechanical Systems Firestopping).
- E. Provide minimum 1" clearance around penetration openings intended for pipe. Size fire-resistant penetration openings as recommended by the firestopping systems manufacturer.
- F. Openings for underground pipes passing through foundations or under footings shall have minimum clearance of 1-1/2" to concrete. Do not disturb footing bearing soil.
- G. Openings for underground pipe passing through on grade concrete slabs shall have minimum 1/4" clearance to concrete. Seal openings with urethane caulk.
- H. Size insulated pipe openings for outside diameter of unless otherwise specified.
- I. Openings for duct penetrations shall be no more than 1/2" larger on all sides than size of duct or duct including duct insulation, if applicable. Where firestopping systems are required at penetrations, size in accordance with recommendations of firestopping systems manufacturer, but opening shall not exceed 1" average clearance on all sides. Openings for ducts with fire dampers shall be in accordance with fire damper installation requirements.
- J. Duct penetrations through concrete floors in mechanical rooms containing liquid heat exchangers and/or pumps shall have 2" high water stopped curbs surrounding openings. This applies to mechanical rooms above the lowest floor level.
- K. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.
- L. Seal non fire-rated wall openings with urethane caulk.
- M. Finish and trim penetrations as shown on details and as specified.
- N. Provide chrome or nickel plated escutcheons in finished areas where exposed piping penetrates walls, floors or ceilings. Size escutcheons so they fit pipe or pipe coverings, providing a finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor closets, storage rooms, etc., unless they have suspended ceilings. Escutcheons applied in wet areas, foodservice areas, and restrooms shall be chrome plated brass or stainless steel.
- O. Trim duct penetrations exposed in finished areas with 2" wide galvanized or aluminum trim collars properly sized to fit duct. Collars shall be same gauge as duct, prime finish unless noted otherwise. Finished areas shall not include mechanical rooms, janitor closets, storage rooms, etc., unless suspended ceilings are specified.

3.04 EQUIPMENT SHUTOFF VALVES

- A. Provide shutoff valves at equipment connected to piping system. Refer to valve section or system section for requirements of valve type.

3.05 EQUIPMENT ACCESS

- A. Install piping, conduit and accessories to permit access to equipment for maintenance. Relocate piping, equipment or accessories to provide access at no additional cost to Owner. The bottom side of all HVAC equipment items such as VAV boxes, reheat coils or inline fans shall be located no more than 18 inches above the ceiling grid where possible due to duct or structural conflicts.
- B. Install equipment with sufficient maintenance space for removal, repair or changes to equipment. Provide ready accessibility to equipment without moving other future or installed equipment or system components. Provide a minimum clearance of 2'-6" from any wall adjacent to the mechanical equipment.
- C. Provide access doors in walls, chases or above inaccessible ceilings for valves, unions or equipment/devices requiring access for servicing, repairs or maintenance, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Provide access doors used in fire rated construction with UL Label. Provide steel, prime coated access doors unless otherwise specified. Provide stainless

steel doors in ceramic tile walls, toilet rooms, locker rooms and in areas subject to excessive moisture. Provide access doors of sufficient size to allow complete maintenance. Coordinate location of access doors with other installers.

3.06 EQUIPMENT SUPPORTS

- A. Provide supporting steel not indicated on Drawings as required for installation of equipment and materials including angles, channels, beams, hangers, etc.
- B. All equipment in mechanical rooms shall be placed on 4-inch high housekeeping pads.

3.07 EQUIPMENT GUARDS

- A. Provide equipment guards over belt driven assemblies, pump shafts, exposed fans, and elsewhere as indicated in this Specification or required by Code.
- B. Paint equipment guards bright yellow.
- C. Equipment guards shall comply with OSHA requirements.

3.08 SUPPORT PROTECTION

- A. In occupied areas, mechanical rooms and areas requiring normal maintenance access, guard certain equipment to protect personnel from injury.
- B. Protect lower edges of equipment and mechanical supporting devices that are suspended less than 7 feet above floors, platforms and catwalks. Apply 1/2" thick closed-cell elastomeric (Type A) insulation. Attach insulation with adhesive. Refer to Section 20 0700 (Mechanical Systems Insulation).
- C. Protect threaded rod or bolts at supporting elements as described above. Trim threaded rod or bolts such that they do not extend beyond supporting element.

3.09 MECHANICAL SYSTEMS IDENTIFICATION

- A. Refer to Section 20 0553 (Mechanical Systems Identification).

3.010 TEST AND BALANCING

- A. Tests for equipment, ductwork and piping systems shall be performed as specified in their respective specification sections in accordance with technical requirements noted.
- B. Provide equipment required for testing, including fittings for additional openings required for test apparatus.
- C. All ductwork and piping inspections and testing shall be successfully completed and approved before application of covering materials.
- D. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or material as necessary and repeat inspection and test until equipment or systems meet test requirements. Make repairs with new materials. Caulking of holes or threaded joints is not allowed.
- E. Certify in writing equipment and system test results. Include identification of portion of system tested, date, time, test criteria, test medium and pressure used, duration of test and name and title of person signing test certification document.
- F. Maintain copies of certified test results, including those for any failed tests, at project site. At completion of Project, include copies of test records and certifications in O&M Manuals.
- G. Balance the various systems in accordance with their associated specification.

3.011 START-UP

- A. Start, test and adjust systems and equipment. Turn over to Owner ready for operation. This includes "Owner-Furnished, Contractor-Installed" (OFICI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.
- B. Follow manufacturer's pre-start-up check-out, start-up, trouble shooting and adjustment procedures.
- C. Provide services of a technician/mechanic that is knowledgeable in start-up and check-out of types of systems and equipment on project.
- D. Provide start-up services by manufacturer's representative when the Contractor does not have qualified personnel, or where specified.

- E. Coordinate start-up with all trades.

3.012 LUBRICATION

- A. Upon completion of work and before turning over to Owner, clean and lubricate bearings except sealed and permanently lubricated bearings. Use only lubricant recommended by manufacturer.
- B. Lubricate mechanical equipment until Owner accepts the work.

3.013 CLEANING

- A. Clean systems after completing installation.
- B. Clean piping and ductwork both internally and externally to remove dirt, plaster dust or other foreign materials. When external surfaces of piping are rusted, clean and restore surface to original condition.
- C. Clean pipeline strainers and filters to restore them to original condition or replace with them with new elements.
- D. Clean equipment and plumbing fixtures as recommended by manufacturers.
- E. Replace throwaway or replaceable media air filters used during construction period with new filters or new filter media after construction has been completed and before building is turned over to Owner. Provide replacement filters as specified.
- F. Clean dirt, plaster dust and other foreign matter from coils, terminal devices, diffusers, registers and grilles.
- G. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.
- H. Provide additional cleaning of individual piping systems and apparatus as hereinafter specified.

END OF SECTION

SECTION 200513
MOTORS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All motors whether integral with equipment or purchased separately.

1.02 RELATED WORK

- A. Section 20 0000 - General Mechanical Requirements
- B. Section 26 2913 - Enclosed Controllers
- C. Section 20 0514 Variable Frequency Drives (VFD) System

1.03 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer
 - 2. Power rating, voltage, phase, hertz, speed
 - 3. Motor type
 - 4. Enclosure type
 - 5. Frame type
 - 6. Insulation class
 - 7. NEMA design designation
 - 8. Service factor
 - 9. Nominal efficiency at full load
 - 10. Power factor at full load
 - 11. Full load amperes
 - 12. Bearings
 - 13. Mountings
 - 14. Dimensions
 - 15. Weight
 - 16. Shaft grounding brush for motors driven by Variable Frequency Drives (VFD)

1.04 PRODUCT CRITERIA

- A. Motors covered by this Specification shall conform to applicable requirements of NEMA, IEEE, ANSI, and NEC Standards and shall be UL Listed where applicable for service specified.
- B. Motors shall be designed for conditions in which they will be required to perform; i.e., general purpose, splash proof, explosion proof, standard duty, high torque or other special type as required by equipment manufacturers.
- C. Select motors so they do not exceed nameplate rating nor operate into service factor to meet specified duty.
- D. Motors located inside air handling units or exposed located in outdoor or wash down environments shall have totally enclosed fan cooled (TEFC) enclosures.
- E. Motors shall be furnished for starting in accordance with utility requirements and be compatible with starters specified hereinafter or under electrical sections of Specifications.
 - 1. Refer to Section 26 2913 - Enclosed Controllers for reduced voltage starting requirements.
 - 2. Starters for NEMA rated 460-volt motors, 60 horsepower and above to be reduced voltage starting type.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials shall be new and guaranteed for service intended.

2.02 MOTORS

- A. Voltage Ratings
 - 1. Refer to equipment schedules and specification sections for voltages required.

2. Unless otherwise indicated, motors 1/3 horsepower and smaller shall be rated 115 volt for operation on 120 volt, single phase, 60 hertz service.
3. Unless otherwise indicated, motors 1/2 horsepower and larger shall be rated:
 - a. 460 volt for operation on 480 volt, single phase, 60 hertz service.
- B. Motors shall be 4 pole (approximately 1750 rpm) unless otherwise noted.
- C. Single-phase motors shall be furnished with built-in thermal overload protection.
- D. Use NEMA Design B motors, normal starting torque with regreasable ball bearings, and Class B insulation unless specified otherwise or unless manufacturer of equipment on which motor is being used has more stringent requirements.
 1. Provide motors with bearings rated for minimum AFBMA 9, L-10 life of 26,280 hours (belted) and 100,000 hours (direct-coupled) at full-load.
- E. Motors shall be rated continuous duty and have 1.15 service factor unless otherwise noted.
- F. Motors Driven by Variable Frequency Drives (VFD)
 1. Motors shall comply with the latest NEMA MG-1, Section IV, Part 31.
 2. Motors shall have service factor not less than 1.0 at rated load.
 3. Insulation shall be Class F or H.
 4. Furnish each motor with shaft grounding ring utilizing conductive microfiber similar to AEGIS SGR to protect motor bearings from electrical damage.
- G. Vibration shall not exceed 0.15" per second, unfiltered peak unless otherwise noted.
- H. Motors (180 frames and larger) shall have provisions for lifting eyes or lugs capable of safety factor of 5.
- I. Full load nominal efficiency of motors 1 horsepower and larger, except special-purpose motors including two-speed or multi-speed motors, and rewind motors, shall meet or exceed listed values when tested in accordance with IEEE Standard 112 Method B as defined by NEMA Standard MG 1-12.6C. Efficiency values listed are based on NEMA Premium Efficiency Electric Motors of NEMA MG 1-2011, Table 12-12.

hp	<u>Open Drip-Proof Motors</u>			<u>Totally Enclosed Fan-Cooled Motors</u>		
	1200 rpm (6 pole)	1800 rpm (4 pole)	3600 rpm (2 pole)	1200 rpm (6 pole)	1800 rpm (4 pole)	3600 rpm (2 pole)
1 hp	82.5	85.5	77.0	82.5	85.5	77.0
1.5 hp	86.5	86.5	84.0	87.5	86.5	84.0
2 hp	87.5	86.5	85.5	88.5	86.5	85.5
3 hp	88.5	89.5	85.5	89.5	89.5	86.5
5 hp	89.5	89.5	86.5	89.5	89.5	88.5
7.5 hp	90.2	91.0	88.5	91.0	91.7	89.5
10 hp	91.7	91.7	89.5	91.0	91.7	90.2
15 hp	91.7	93.0	90.2	91.7	92.4	91.0
20 hp	92.4	93.0	91.0	91.7	93.0	91.0
25 hp	93.0	93.6	91.7	93.0	93.6	91.7
30 hp	93.6	94.1	91.7	93.0	93.6	91.7
40 hp	94.1	94.1	92.4	94.1	94.1	92.4
50 hp	94.1	94.5	93.0	94.1	94.5	93.0

	<u>Open Drip-Proof Motors</u>			<u>Totally Enclosed Fan-Cooled Motors</u>		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
hp	(6 pole)	(4 pole)	(2 pole)	(6 pole)	(4 pole)	(2 pole)
60 hp	94.5	95.0	93.6	94.5	95.0	93.6
75 hp	94.5	95.0	93.6	94.5	95.4	93.6

- J. Single-phase motors for hard starting applications including outdoor applications shall be capacitor start type. Motors for fans and pumps located indoors may be split phase or permanent split-capacitor. Motors shall be equipped with permanently lubricated and sealed ball bearings and shall be selected for quiet operation. Motors 1/8 horsepower and below may be shaded pole type.
 - 1. Refer to individual equipment section for additional requirements or specific type of motors.
- K. Three-phase, two-speed motors shall be one winding, consequent pole, variable torque type and single-phase, two-speed motors shall be capacitor start capacitor run type.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install materials in accordance with drawings, approved Shop Drawings and manufacturer's recommendations.

END OF SECTION

SECTION 20 0514
VARIABLE FREQUENCY DRIVE (VFD) SYSTEM

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 20 0513 – Motors
- B. Section 23 2123 - Pumps
- C. Section 23 3400 - Fans
- D. Section 23 7400 – Packaged Rooftop Air Handling Units
- E. Section 26 2816 - Enclosed Switches and Circuit Breakers
- F. Section 26 2913 - Enclosed Controllers

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SYSTEM DESCRIPTION

- A. Provide Variable Frequency Drives (VFD) for each fan or other driven equipment sized to accommodate motors shown on drawings or schedules. All VFD's shall be from same manufacturer.
- B. VFD manufacturer shall review driven equipment and motors for VFD compatibility. Submit written statement from manufacturer of driven equipment along with VFD shop drawing submittals, indicating verification of compatibility.
- C. Contractor shall verify distance from motors to VFD's. VFD manufacturer shall provide sufficient equipment to assure proper operation and to avoid premature motor failure.
- D. VFD manufacturer shall provide filter equipment as necessary to limit voltage transient ring wave stress placed on stator windings to withstand rating value of motors supplied per Section 20 0513 - Motors.
- E. VFD shall vary speed of its respective fan or other driven equipment motor in response to control signal from packaged controller.
- F. VFD system shall consist of the following:
 - 1. Variable frequency drive
 - 2. UL Listed disconnect device
 - 3. Electrical noise attenuation device as required to meet electrical noise criteria.
 - 4. Motor starter for bypass mode operation with VFD/OFF/BYPASS selector and drive input and output isolation contactors where VFD bypass starters are specified.
 - 5. Line reactor
 - 6. Step-up or step-down isolation transformer as required
- G. VFD system shall be furnished by a manufacturer with at least 5 yrs experience in design, construction and application of VFD.

1.04 SUBMITTALS

- A. Shop Drawings for each VFD system including, but not limited to, the following:
 - 1. Manufacturer's name
 - 2. Identification of system components
 - 3. Type of enclosure, front elevation and plan view, equipment weight, conduit access locations
 - 4. Capacities/ratings
 - 5. Warranty
 - 6. System wiring and block diagram showing system components
 - 7. Performance, control and protection data with specified features clearly shown
 - 8. Operating and monitoring devices with specified features clearly indicated
 - 9. Start-up operation, maintenance, spare parts, and field tests
 - 10. Manufacturer's installation instructions

11. Other appropriate data
 12. Variations from this Specification
- B. After quality control tests are complete, submit written certification that drive and components have passed factory quality control tests.
 - C. Submit product and performance data on electrical noise attenuation device if required to meet electrical noise criteria specified. Isolation transformer is not electrical noise attenuation device.

1.05 ELECTRICAL NOISE CRITERIA

- A. Voltage and current distortion generated by VFD and attenuation devices measured at input of VFD assembly and as installed in place, shall not exceed the following criteria as referenced by IEEE Standard 519.
 1. Total harmonic distortion (THD) shall not exceed 5% RMS of fundamental input voltage at full load with maximum RMS value on any signal harmonic based on IEEE 519-1992 Table 10.3.
 2. Point of Common Coupling: Secondary distribution (480Y) of service transformer.
 3. The service transformer for this application shall not be subjected to harmonic currents in excess of 5% of transformer rated current in accordance with ANSI/IEEE Standard 519-1992, paragraph 10.4.1.

1.06 START-UP OPERATION AND MAINTENANCE DATA

- A. Manufacturer shall provide services of factory trained engineer or technician to approve installation; start-up test and adjust for proper operation.
- B. Should drive be deficient, drive manufacturer shall be required to make changes necessary to bring units into compliance with specified performance requirements. Cost of changes and retest shall be borne by drive manufacturer.
- C. Upon completion of this service, submit a report signed by manufacturer's service representative, including start-up and test log. Report shall document all setpoints and user-adjustable parameters as configured on each drive.
- D. Manufacturer shall provide a 3-year parts and labor warranty on all VFDs including those provided with packaged air handling unit systems covering parts, labor and travel expenses.
- E. Acceptable VFD manufacturers must have an authorized service provider within a two-hour drive from the project location and be able to respond to a warranty related problem within two hours.
- F. All motors intended for VFD use shall be labeled for "inverter duty".
- G. All VFDs shall be provided with a manual bypass starter.
- H. All VFDs must be provided from the factory to with the ability to communicate directly with the BAS.
- I. Where possible the VFDs are to be located in a conditioned space.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Manufacturers: ABB, Eaton, Danfoss, Yaskawa.

2.02 HARMONIC MITIGATION

- A. Drives 15 hp and larger shall incorporate one of the following harmonic mitigation features:
 1. 18-pulse technology.
 2. Ultra-low harmonic drives: ABB ACS800 Series.
- B. Drives smaller than 15 hp: 6-pulse technology with 5% line reactor.

2.03 FABRICATION

- A. VFD shall be variable torque, solid state, microprocessor based control, modular design for standard induction AC motor.
- B. VFD components shall be factory mounted and wired in NEMA 1 enclosure with lock.

- C. VFD components shall be factory mounted and wired in Motor Control Center enclosure.
- D. Circuitry shall be plug-in, plug-out modular. Printed circuit boards shall have protective coating to reduce corrosion.
- E. Unit shall conform to NEMA and NEC standards and be CSA, UL or ETL Listed. Control circuitry shall be electrically isolated from power circuitry. Entire assembly panel shall have UL or equivalent panel sticker.
- F. Inverter section shall be pulse width modulated (PWM) design and most current insulated gate bipolar transistors (IGBTs) technology.

2.04 PERFORMANCE REQUIREMENTS

- A. Input: 460 (+ 10%, - 15%) VAC, 3-phase, 60 (± 2) Hz
- B. Output: 460 VAC, 3-phase, 10 to 60 Hz
- C. Operating Environment Conditions: Ambient 0 to 40°C temperature, relative humidity up to 95% non-condensing.
- D. Linear acceleration and deceleration adjustable from 5 to 60 seconds. Provide adjustable v/Hz ratio and low speed boost features.
- E. Output Current Rating: Continuous full load output current rating of drive shall not be less than that listed for motor of equivalent horsepower in NEC table 430-150.
- F. Drive overload capacity to be minimum 110% of motor FLA based on NEC ratings for one minute.
- G. Time to Shutdown: Inversely proportional to square of overload current ($t = k/I^2$).
- H. Motor Regeneration Protection: Unit shall have capacity of dissipating regeneration energy without damage to or shutdown of drive. Unit shall be capable of starting into rotating load.
- I. Output Frequency Stability: ± 0.5% of base frequency in 24 hrs throughout range of rated operating conditions.
- J. Output Voltage Regulation: ± 2% of maximum rated output voltage.
- K. Output voltage rise time shall be no faster than 1000 V/micro sec measured at the motor terminals. If power and control cable between VFD and motor is more than 100 ft, provide dv/dt output filter.
- L. Power Loss Ride-Through: 3 cycles or 50 milliseconds.
- M. Linearity (speed reference to output frequency): ± 1.0%
- N. Input Power Factor: Minimum of 0.95 regardless of speed and load.
- O. Minimum drive efficiency as percent of input power shall be as follows:

<u>Percent Load</u>	<u>Frequency (Hz)</u>			
	<u>60</u>	<u>50</u>	<u>30</u>	<u>15</u>
100	97	96	95	90

2.05 CONTROL FEATURES

- A. VFD speed control circuit shall accept either 4-20 mA DC or 0-10 VDC isolated ungrounded transmitter signal in automatic mode and from manual speed potentiometer in manual mode.
- B. Provide adjustable minimum and maximum speed settings (0 - 100%) for both auto and manual mode. Initial minimum setting shall be 25%.
- C. Provide adjustable automatic reset for fault trips, except short circuit type faults. After selected number of unsuccessful restart attempts, drive shall be shut down. Number of restart attempts and time interval between resets shall be selective.
- D. When unit shuts down due to power outage, unit shall be capable of being restarted manually or automatically.
- E. VFD shall be capable of starting into rotating loads spinning in any direction.
- F. Provide critical frequency avoidance circuit with at least 3 field adjustable bands to avoid operation at speeds, which cause excessive vibration in driven equipment.

2.06 OPERATING AND MONITORING DEVICES

- A. The following functionality shall be provided and may be controlled via touchscreen/keypad:
 - 1. Door interlock to disconnect VFD input power
 - 2. Manual stop/start device
 - 3. Operating mode selector device marked "Manual-Off-Automatic"
 - 4. Manual speed control potentiometer
 - 5. Power on indication
 - 6. Drive run indication
 - 7. Drive fault indication with testable feature
 - 8. Fault reset device
- B. Power circuits shall be protected by, electronic protection circuits. Electronic protection circuits shall provide orderly shutdown without blowing fuses and prevent component loss under the following abnormal conditions.
 - 1. Instantaneous overcurrent and over voltage trip of output
 - 2. Solid state protective circuit shall provide NEC motor running overload protection tested in accordance with UL Standard 991
 - 3. Power line overvoltage or undervoltage
 - 4. Phase sequence detection or insensitivity to incoming power phase sequence
 - 5. Single and 3-phase short circuit protection
 - 6. Control circuit malfunction
 - 7. Overtemperature
 - 8. Ground fault for all 3 phases
- C. VFD shall protect itself from damage due to phase-to-phase or phase-to-ground faults without fuse blowing or use of isolation transformers. VFD's which require isolation transformers to provide ground fault protection are not acceptable.
- D. In addition, provide the following protection features:
 - 1. Input line-to-line and line-to-ground transient protection up to 3000 V
 - 2. Control circuit transformer fusing
 - 3. Grounded control chassis
 - 4. Diagnostic indication
 - 5. One set of spare fuses for each type used in drive for each VFD
- E. Interlock VFD control circuits with driven motor's disconnect switches where such motor disconnect switches are provided. Disconnecting on-line motor shall shut down VFD. VFD shall restart upon reconnection of motor.
- F. VFD shall employ adjustable torque limit control, which shall override speed command and decrease frequency while maintaining correct volts/hertz ratio whenever load level surpasses VFD design level or set point.
- G. Speed indicating meter or digital indication (0 - 100%) calibrated in percent speed or frequency meter with 0 to 90 Hz scale to indicate motor speed.
- H. Integral digital programming and operating display which shows Hz, Percent Output Current, Output Voltage, Percent Output Power, Operating Parameters and their values, and Diagnostic Fault Codes. In addition, Keypads shall be incorporated to facilitate digital programming of drive adjustments. Analog potentiometer adjustments are not acceptable.
- I. Provision shall be included to provide selectable programming security by inhibiting program parameter changes with internal dip switch setting or with password security.
- J. Control shall incorporate microprocessors for operator interface, diagnostics, and fault managements, and power management.
- K. Optional DOS-based programming software, which includes provision for serial communication with drive, shall be available for shipment at time of equipment order placement.
- L. Fault buffers to sequentially store last 4 faults. Parameter and fault information to be stored in non-volatile memory.
- M. VFD with Bypass Device (Manual Bypass Starter):

1. Manual selector switch to select power through VFD or bypass line with label marked "VFD/OFF/BYPASS".
2. Mechanically- and electrically-interlocked VFD/BYPASS contactors with padlocking capability on input side of VFD and bypass device. Interlock shall be accomplished such that shorting together of any 2 control circuit points can not cause non-selected device to be energized. Provide mechanically-and electrically-interlocked device that connects only output of selected starting device (primary VFD or bypass device) to VFD system output lug. Single shorting of any 2 control circuit points shall not cause both VFD and bypass device outputs to be interconnected.

2.07 QUALITY CONTROL TESTS

- A. For all VFDs, the complete drive assembly shall be factory tested with actual AC induction motors, 100% load and temperature cycled within environment chamber at 40°C (104°F). Documentation of tests shall be furnished to verify successful completion of test at Engineer's request.

2.08 DISCONNECT DEVICE

- A. Provide integral switch to disconnect incoming electrical power to units. Disconnect device shall be UL Listed device of the following:
 1. Motor circuit switch: horsepower rated
 2. Enclosed molded case breaker; ampere rated and providing over current protection
 3. Molded case switch; ampere rated enclosed switch with or without over current protection
 4. Rotary switch: with or without fuser
- B. Unit shall have an interrupting rating not less than that of the upstream overcurrent device as shown on electrical drawings.
- C. Disconnect shall be capable of being padlocked in OFF position and complying with OSHA Requirements. Operating handle shall indicate whether switch is "ON" or "OFF".
- D. Switch shall have dual cover interlock to prevent unauthorized opening of switch door when handle is in "ON" position and to prevent closing of switch mechanism with door open. Provide defeater mechanism to defeat the interlock for user required access.

2.09 MOTOR CONTROL EQUIPMENT (BYPASS STARTERS)

- A. Bypass starter shall be NEMA or IEC Rated device of the following:
 1. Electromechanical across-the-line starter with solid state overload protection.

2.010 LINE REACTORS

- A. Series line reactors shall be designed for harmonic filtering service and shall be UL component recognized. Construction shall be copper wire wound on steel cores. Inductors shall be 3-phase. Series line reactors shall be sized at 5% impedance and appropriately for total connected load. Design maximum temperature rise for inductors shall be 115°C.
- B. Core shall be made of laminated grain oriented electrical steel (grade M6 or better). Brackets shall be ASTM structural steel or structural aluminum. Coils shall be wedged in place and core locked in place using vertical ties or rods.
- C. Windings shall be copper wire, MW35C (round) or MW36C (rectangular) or copper foil. Terminations shall be tin plated copper alloy ring lugs, UL recognized terminal blocks, or solid copper bus. Terminations shall be pressure crimped or TIG welded to windings. Sheet insulation shall be DuPont Nomex 410 of thickness meeting UL insulation systems.
- D. Inductors shall be double impregnated (vacuum/pressure impregnate and bake followed by varnish dip and bake). Insulation systems shall be rated Class H (180°C), 600 V. Inductors shall be Hi-Pot tested (2500 V, 60 Hz, 1 minute) line-to-line and line-to-ground.
- E. Inductors shall be air-gapped to avoid saturation. Inductance shall be measured under full load and shall be within $\pm 5\%$ of design value.
- F. Line reactor shall be included integral to drive enclosure.

1. Where mounting line reactor in VFD enclosure is not possible, enclosure shall be steel with enamel finish and no knockouts. Enclosure shall match construction of VFD enclosure and shall have hinged lockable cover. Screened openings shall be provided for enclosure ventilation. Enclosure shall be built with integral mounting brackets for platform or wall mounting. Coordinate location with other trades.

2.011 SPARE PARTS

- A. Provide additional enclosure cooling fan for each different type of drive.
- B. Provide additional key pad/touch screen for each different type of drive.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Visually inspect equipment and components at time of delivery. Submit report to Engineer with list of items or deficiencies to be corrected.

3.02 PROTECTION

- A. Protect VFD cabinets from dust/dirt during storage and operation until turned over to Owner.
- B. If VFDs are not furnished with internal air filter racks, provide temporary filter media to protect VFD cabinets and replace filter media as required.

3.03 INSTALLATION

- A. Install VFD system in accordance with details, approved Shop Drawings and manufacturer's instructions and recommendations.
- B. Provide field low voltage wiring of VFD system components. Provide field interconnecting wiring between VFD and by-pass starter if bypass starter is specified and the wiring is not installed at factory. Install wiring in metal conduit and in accordance with Electrical sections of this Specification and applicable Electrical Code.
- C. Provide control wiring between interlocks in VFD control circuits and driven motor's disconnect switches, where such motor disconnect switches are provided.
- D. Do not connect ground from one unit to another unit's cabinet.
- E. Use separate conduits for incoming and outgoing power conductors from each unit.
- F. Use separate conduit for control wiring for each unit. Control wiring shall not occupy same conduit as power wiring.
- G. Use minimum 18 ga shielded wiring with ground for control wiring.
- H. Install floor mounted drives on 3-1/2" (85mm) high concrete housekeeping pad.

3.04 START UP

- A. Perform start-up of VFD in accordance with procedures as defined by manufacturer for proper operation.
- B. Adjust critical frequency avoidance feature to step over frequencies which cause excessive vibration in driven equipment.

3.05 FIELD QUALITY CONTROL

- A. **WARRANTY:** The warranty period shall begin at Substantial Completion for a minimum of 3 years.

END OF SECTION

**SECTION 200520
EXCAVATION AND BACKFILL**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section lists methods and materials for trench excavation and backfill for underground mechanical, plumbing and fire protection piping systems inside and outside the building.

1.02 RELATED WORK

- A. Section 20 0000 - General Mechanical Requirements

1.03 SUBMITTALS

- A. List of materials to be used for backfill.

PART 2 - PRODUCTS

2.01 MATERIAL COMPATIBILITY

- A. Corrosive Fill Materials: Do not use of backfill or bedding materials that may become corrosive to pipe or piping components, with or without the presence of moisture. These materials include but are not limited to controlled density backfill products as well as backfill materials containing fly ash, cinders, or other corrosive materials.

2.02 FILL MATERIAL

- A. Type 1 Fill: Material from excavation separated from materials, which do not compact by tamping and rolling. No stones larger than 3" and no building, organic, corrosive or frozen materials.
- B. Type 2A Fill: Sand or gravel materials with none larger than 2" and of that portion passing #4 sieve less 5% to pass #200 sieve.
- C. Type 2B Fill: Sand or gravel materials with none larger than 1/2" and of that portion passing #4 sieve less 5% to pass #200 sieve.
- D. Type 3 Fill: Gravel of rounded to subangular shape, screened, which will pass 0.75" sieve and retained on #4 sieve.
- E. Type 4 Fill: Pit run rock or gravel with maximum stone size of 1".
- F. Type 5 Fill: Pea gravel, screened, which will pass 0.375" sieve and retained on #4 sieve.
- G. Type 6 Fill: Soils Engineer approved fill material, backfilled and compacted beneath building footprint.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Establish grade lines and locations of piping and manholes. Provide necessary stakes and batter boards.
- B. Verify invert elevations of existing utilities prior to excavation for new utility piping.
- C. Locate existing underground utilities and mark their locations at least 48 hours, but not more than 10 business days prior to excavation.
- D. Review soil test reports and existing site conditions prior to bid. Take all necessary precautions to maintain safety and proper work procedures.

3.02 EXCAVATION

- A. Provide excavation for all underground work, including piping, manholes, catch basins, tanks, concrete structures, etc., unless otherwise shown or specified. Lay piping in open trench except when Architect gives written permission for tunneling.
- B. Include all necessary clearing; tree removal; grubbing; pavement removal; substructure removal such as walls, footings and piers and all incidental work such as tunneling, sheet piling, shoring, underpinning, pumping, bailing and transportation. Coordinate excavation extending beyond construction limits with Owner.
- C. Notify the Architect about existing unstable soils before commencing excavation.

- D. Saw cut existing on-grade concrete floor slabs, where required.
- E. Trench excavations shall be a minimum of 16" wide, true to line and grade. Provide shoring as required and maintain proper safety procedures. Remove stones larger than 3/4" to a minimum 4" below the trench bottom. Maintain trenches free of excess moisture, jobsite debris, and corrosive media.
- F. Do not over-excavate trench bottoms except where required due to existing soil conditions or specific material installation requirements.
- G. Keep trenches open only as necessary for installation, testing, inspection, and Architect's field observations.
- H. Do not excavate parallel to and deeper than building footing bottoms, unless the trench bottom is above a 45 degree angle of repose from the footing.
- I. Do not blast rock without written permission of Architect and Owner.
- J. Remove all excess excavation material from site unless directed otherwise.
- K. Use mechanical methods to remove rock in trenches for piping systems.
- L. Include rock excavation in the Bid unless otherwise indicated.

3.03 PIPE INSTALLATION

- A. Keep underground piping to proper line and grade and sealed at all times to prevent entrance of animals or foreign matter.
- B. Provide bracing and sheet piling as necessary to support trenches. Comply with Local Regulations, applicable provisions of OSHA Regulations on trenching, or with provisions of "Manual of Accident Prevention in Construction" published by Associated General Contractors of America.
- C. Under no circumstances lay pipe or install appurtenances in water. Keep trench free from water until pipe joint material has hardened.
- D. Presence of ground water in soil or necessity of sheet piling or bracing trenches shall not constitute condition for which any increase may be made in Contract price, except when sheet piling is left in place on written order of Owner, Contract price will be adjusted.
- E. Cut off sheet piling left in place not less than 2" below new finished grade. Do not remove sheet piling until trench is substantially backfilled.
- F. Place underground piping outside and inside building in open excavated trenches. Where trench bottom does not contain stones larger than 1" in size or where bedrock is not encountered, trench may be excavated to final pipe grade. Where bedrock or stones larger than 1" is encountered, excavate entire length of trench to depth 4" below final pipe grade elevation and provide 4" of pipe bedding material compacted to minimum of 90% Standard Proctor Density consisting of Type 2B, Type 3 or Type 5 fill to establish final pipe grade. Shape bedding for clearance for all joints and fittings, tamped in place and graded evenly to insure uniform bearing for full length of pipe. Do not support piping by blocking, planking or mounding of bedding material.

3.04 BACKFILL

- A. Exterior:
 - 1. Do not backfill outside building or beyond construction limits only after piping and appurtenances have been inspected, recorded, tested and approved.
 - 2. Backfill by hand around pipe in 6" layers to depth of 12" above top of pipe with Type 2B, Type 3 or Type 5 fill. Do not to disturb pipe or damage pipe coating. Do not use Type 3 fill where it will come in contact with polyethylene encasement. Compact backfill thoroughly with compactor of suitable weight or with approved mechanical tamper. Do not use water flooding or jetting.
 - 3. Place remaining backfill in 8" layers with Type 1 fill. Compact backfill until it matches the density of surrounding soils.
 - 4. Backfill under walks, roads, driveways or parking areas from 12" above pipe to subgrade with Type 2A, Type 2B, Type 3 or Type 4 fill. Backfill in 12" layers and compact with

mechanical means to density 95% modified proctor. Test compaction testing shall be determined by testing consultant, based on site conditions, materials and workmanship.

5. When excavation occurs on public property or areas beyond property line, all excavation, pipe laying, backfilling, grading and surfacing shall conform as herein specified, except additional requirements for public utility or other authorities shall be complied with when in order. Check with each utility and incorporate cost of any additional requirements in Base Bid.

B. Interior:

1. Backfill inside building only after piping and appurtenances have been inspected and approved. Backfill to 12" above pipe with Type 2B, 3 or 5 fill in 6" layers. Remainder of backfill shall be Type 2A, Type 2B, Type 3, Type 4, or Type 6 fill in 12" layers.
2. Install lines passing under foundations with minimum of 1-1/2" clearance to concrete and insure there is no disturbance of bearing soil.

3.05 ROCK EXCAVATION

- A. Consider material over one cubic yard in size encountered during excavation as rock. Rock excavation will be paid as extra if it cannot be removed by 200 net horsepower crawler tractor with ripper attachment all in good running condition and operated by an experienced individual.
- B. Excavate rock to 4" below intended pipe invert.

3.06 FINISHING

- A. On completion of trenching and backfilling operations, restore grades to original elevation or to new subgrade elevation.
- B. When trenching is through existing areas or beyond constructions limits, replace surfaces to existing conditions.
- C. When trenching through existing landscaped areas backfill to a subgrade elevation 6" below original surface elevation. Provide 6" of topsoil. Provide landscaping to match existing landscaping or as otherwise approved by the Architect.
- D. Patch existing concrete floor slabs to match existing finishes.

END OF SECTION

**SECTION 200529
MECHANICAL SUPPORTING DEVICES**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 20 0000 - General Mechanical Requirements
- B. Section 20 0700 - Mechanical Systems Insulation
- C. Section 23 0550 - Vibration Isolation (Spring Hangers and Mounts)
- D. Section 23 2116 – Pipe and Pipe Fittings
- E. Section 23 3114 - Ductwork (for additional duct supports requirements)

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 DESCRIPTION

- A. Provide all supporting devices as specified and as required for proper support of piping, ductwork, equipment, materials and systems.
- B. Support for all conditions of operation, including variations in installed and operating weight of equipment, piping and ductwork, to prevent excess stress and allow for proper expansion and contraction.
- C. Support of fire protection pipe shall comply with this Section and NFPA 13, Installation of Sprinkler Systems, 2007 Edition.

1.04 SUBMITTALS

- A. Shop Drawings for each piping system for all pipe sizes and all applicable equipment including, but not limited to, the following:
 - 1. Manufacturer's name
 - 2. Model numbers
 - 3. Materials of construction and load ratings lbs
 - 4. Schedule of hangers and support devices with pipe support spacing
 - 5. Insulated pipe supports along with application chart or table
 - 6. Insulation protection saddles and weight bearing insulation table
 - 7. Details and calculations for sizing supplementary steel utilized for trapeze or specially designed supports
 - 8. Structural attachments, inserts and concrete anchors
 - 9. Calculations and drawings for concrete anchors for each application
 - 10. Drawings showing specific locations of any weld attachments to structure, including weight supported by such attachments
 - 11. Equipment mounting devices
 - 12. Pipe guides and anchors
 - 13. All other appropriate data

1.05 DESIGN CRITERIA

- A. Materials and application of pipe hangers and supports shall conform to latest requirements of ANSI/ASME Code for Pressure Piping B31.1 and MSS Standard Practice SP-58 (Materials, design and Manufacture), SP-69 (Selection and Application), and SP-89 (Fabrication and Installation Practices), except as supplemented or modified herein.
- B. Support materials shall be steel or stainless steel unless specifically indicated.
- C. Support devices shall be factory fabricated by manufacturers and have published load ratings.
- D. Unless otherwise indicated, design structural support members and support devices, including couplings, rods, trapeze supports and strut systems, with safety factor in accordance with AISC Manual of Steel Construction, but not less than 2.0.
- E. Determine maximum deflection using the following equation.

$$D = \frac{H \text{ or } L}{250}$$

Where D = Max deflection in inches
 H = Member height in inches
 L = Member length in inches

- F. Unless otherwise indicated, hangers, support devices and hardware shall be steel and shall have factory standard black, primed, galvanized or electroplated finish for indoor application
- G. Material in contact with pipe shall be compatible with piping material so that neither shall have deteriorating action on the other. If materials such as copper, stainless steel or other materials are not compatible, provide nonmetallic separation between uninsulated piping and metal supports. Plastic coated steel supports are acceptable.
- H. Unless otherwise indicated, steel support devices exposed to ventilation air stream shall be stainless steel or steel with either galvanized finish or paint finish. Paint type shall be approved by Architect/Engineer.
- I. This Contractor is responsible for proper placement and sizing of supporting devices to accommodate insulation thickness and pitching of pipe. Coordinate with Contractor performing work specified in Section 20 0700 - Mechanical Systems Insulation.
- J. Piping connected to coils, which are in assembly mounted on vibration isolators, shall have vibration supports as indicated above.
- K. Where piping can be conveniently grouped to allow trapeze type supports, supporting steel shall be by means of standard structural shapes.
- L. Hangers and rods shall be plumb when pipelines are at their normal operating temperatures.
- M. Unless otherwise indicated, continuous insert channels are not allowed.
- N. Punching, drilling, or welding of building structural steel is not allowed unless approved by Structural Engineer.
- O. Application of concrete inserts and concrete anchors shall be reviewed and approved by Structural Engineer prior to installation.
- P. Any proposed weld attachments to building structure shall be reviewed by Structural Engineer prior to execution of work. This review may result in use of other welding codes or standards, which may apply to "structural work". Execution of this work may be assigned to General Trades responsible for building structural steel. Cost for this work, however, will remain the responsibility of this Contractor.

PART 2 - PRODUCTS

2.01 STRUCTURAL SUPPORTS

- A. Provide all supporting steel, not indicated on structural drawings, that is required for installation of mechanical equipment and materials, including angles, channels, beams, etc. to suspend or floor support equipment.

2.02 PIPE HANGERS AND SUPPORTS (METALLIC)

- A. Manufacturers: Anvil (formerly Grinnell), Erico, Tolco, National Pipe Hanger Corporation, or B-Line, equal to Anvil figures listed. Corresponding MSS Type is indicated where applicable.
- B. Hangers/supports for copper pipe where supports directly contact to pipe shall be either copper plated or PVC coated.
- C. For insulated pipe supports, refer to Insulated Pipe Supports in Part 3 of this Section.
- D. Clevis and Roller Type Hangers:

<u>System</u>	<u>Pipe Size</u>	<u>Clevis</u>	<u>Roller</u>
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Hot Pipes with Insulation (120°F and above)	2" and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2" to 6"	---	171 (MSS Type-41), 181 (MSS Type-43)
	8" and larger	---	171 (MSS Type-41)
Ambient Bare Pipes (60°F to 119°F)	2" and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2" and larger	260 (MSS Type-1), 216 (MSS Type-4)	---

- For pipe size 2-1/2" and larger, where there is transverse movement at support points due to thermal expansion/contraction, clevis type hangers similar to Anvil Figure 260 (MSS Type-1) may be used if vertical angle of hanger rod is less than 4°.

E. Adjustable Swivel Band Hangers: Anvil Figure 96

- Do not use for pressure piping larger than 2" diameter.
- Do not use for drainage piping larger than 4" diameter.

F. Flat Surfaces (Trapeze, Rack Type):

- Use structural steel members such as struts, angles, channels and beams to support pipes as required. Select members properly for pipe support types and loading conditions. Refer to Part 1 for design criteria. Submit support details with type of members selected and load calculations. Provide straps, clamps, rollers or slides indicated below at each support point.

<u>System</u>	<u>Pipe Size</u>	<u>Straps or Clamps</u>	<u>Rollers</u>	<u>Slides</u>
Hot Pipes with Insulation (120°F and above)	2" and smaller	243, 244	---	---
	2-1/2" and larger	---	177, 271 (MSS Type-45), 274 (MSS Type-46)	257 or 436 with 212 or 432 clamps, Type 1, 2 or 3 for longitudinal movement only and Type 4, 5 or 6 for both longitudinal and transverse movement of piping.
Ambient Bare Steel Pipes (60°F to 119°F)	6" and smaller	B-Line BVT	---	---
	8" and larger	137 (MSS Type-24)	---	---
Ambient Bare (Copper) pipes (60°F to 119°F)	all sizes	B-Line BVT	---	---

2.03 INSULATION PROTECTION SHIELDS

- Anvil Fig. 167 (MSS Type-40) constructed of galvanized carbon steel. Per the latest edition of Standard MSS SP-58, select shield to accommodate outer diameter of insulation. Shield length and gauge for insulation compression strength not less than 15 psi, shall be as follows:

<u>Pipe Size</u>	<u>Length</u>	<u>Gauge</u>
1/4" thru 3"	12"	18
4"	12"	16

2.04 WEIGHT BEARING INSULATION INSERTS

- A. Insert thickness shall match pipe insulation thickness. Pipe insulation jackets shall be continuous through sections containing inserts.
- B. Minimum length of inserts shall be 12", or 2" longer than insulation protection shields, whichever is longer. Quantity and placement of inserts shall be based on weight of pipe and fluid plus 1.5 safety factor.
- C. Hot Pipes (120°F and above):
 - 1. Type H or Type G insulation. Maximum compression strength for load calculation shall be 90 psi.

2.05 PRE-INSULATED PIPE SUPPORTS

- A. Pipe Shields, Inc., Bergen Pre-Insulated Pipe Supports, Rilco, or Tri-State Industries equal to Pipe Shields models listed
- B. Insulation shall consist of water-resistant calcium silicate of same thickness as adjoining pipe insulation, thermal conductivity not more than 0.38 Btu·in/(hr·ft²·°F at 75°F mean temperature, minimum density of 13 lb/ft³, and compressive strength not less than 100 psi.
- C. Structural inserts shall be water-resistant, high-density calcium silicate with minimum density of 32 lb/ft³ and minimum compressive strength of 600 psi. Structural inserts shall be used as recommended by manufacturer to meet load ratings.
- D. Use vapor barrier steel jacket around insulation. Insulation jackets shall be galvanized steel conforming to ASTM A-527. Hanger bearing surface shall consist of galvanized sheet metal insulation protection shield or casing.
- E. When recommended by manufacturer, use double layer insulation protection shield at support bearing surface. Insulation shall extend 1" beyond insulation protection shield to maintain vapor barrier integrity.
- F. Pre-insulated pipe supports shall be load rated. Load ratings shall be established by pipe support manufacturer based upon testing and analysis in conformance with the latest edition of the following codes and standards: ASME B31.1, MSS SP-58, MSS SP-69, and MSS SP-89.
- G. Load tests shall be made on both supporting materials and configurations. All tests shall be performed by independent testing laboratory. Results of pertinent tests shall be available upon request.
- H. Unless otherwise indicated, pre-insulated pipe supports shall be as indicated in the following schedule. Model numbers are based on Shaw Pipe Shields, Inc.
 - 1. Pipe supported on hangers: Models A2000, A4000, A9000, D3000 and D3200
 - 2. Pipe supported on flat surfaces: Models A2000, A4000, A6000, A7000, A7200, and A7400
 - 3. Pipe supported on pipe rolls: Models A4000, A6000, A8000, A8200, and A8400
 - 4. Pipe supported on slides: Model "B" Series
 - 5. A1000, A3000 or A5000 may be used for hot pipes (120°F and above)
- I. Select proper model to conform to pipe service, support style, and support spacing.
- J. Submit chart or table indicating selected model along with pipe sizes, rated loads, support device types and support spacing for each piping system.
- K. Pipe support spacing shall be in accordance with manufacturer's recommendations, but in no case shall exceed maximum spacing indicated under Hanger and Support Spacing in Part 3 of this Section.

2.06 HANGER RODS (METALLIC)

- A. Rods shall conform to the latest MSS Standards except as modified herein. Furnish rods complete with adjusting and lock nuts.
- B. Rods shall have electroplated zinc or hot dip galvanized finish.

- C. Unless otherwise indicated, size rods for individual hangers and trapeze support as indicated in the following schedule. Rod size may be reduced one size for double rod hangers. Total weight of equipment, including valves, fittings, pipe, pipe content and insulation, shall not exceed limits indicated.

<u>Max. Pipe Size With Single Rod</u>	<u>Rod Diameter (millimeters(inches))</u>	<u>Max Load (lbs) of Hanger Rod (Not exceeding (650°F) Service Temp.)</u>
2"	3/8	730
3"	1/2	1350
5"	5/8	2160

2.07 BOLTS, NUTS, STUDS AND WASHERS

- A. ASTM A307, electroplated zinc finish

2.08 ROD ATTACHMENTS

- A. Anvil Fig. 290 (MSS Type-17), galvanized finish

2.09 U-BOLTS

- A. Anvil Fig. 137 (MSS Type-24), galvanized finish

2.010 RISER CLAMPS

- A. Anvil Fig. 261 (MSS Type-8), galvanized finish
 B. Anvil Fig. CT-121, copper plated carbon steel, plastic coated in area at pipe contact, for bare copper tubing
 C. Proset system, proseal plug and fire-fill for sleeved and cored holes.

2.011 CONCRETE ANCHORS

- A. Manufacturers: Hilti, Powers Fasteners or Red Head
 B. Anchors shall be designed and detailed by Contractor's structural engineer registered in project's jurisdiction. Calculations and drawings shall be submitted.
 C. Anchors shall meet ICC Acceptance criteria, and ICC-ESR reports shall specifically list the current applicable codes.
 D. Anchors installed in hardened concrete for purpose of transmitting structural loads from one connected element to another, or for safety related elements such as sprinkler pipes, heavy suspended pipes, and barrier rails shall have ICC-ESR report demonstrating anchors have met requirements of AC 193 for mechanical anchors.
 E. Post-installed expansion anchors and undercut anchors installed in hardened concrete shall be qualified for strength design and tested according to ACI 355.2. Designs shall be per the requirements of ACI 318, Appendix D.
 F. Anchors shall be zinc plated in accordance with ASTM B633.
 G. Select anchors with load ratings based on cracked concrete conditions.

2.012 METAL FRAMING SUPPORT SYSTEM (STRUT SYSTEM)

- A. Manufacturers: Unistrut, B-Line Strut Systems, Anvil-Strut, Power-Strut, Erico, Superstrut, Kindorf, and Hydra-Zorb
 B. Channels shall have epoxy paint or electroplated zinc finish.
 C. Channels shall not be lighter than 12 ga.

2.013 CASEWORK PIPE SUPPORTS

- A. Hinged pipe clamp and Strutcatcher, nylon 12 Grilamid, Clic by Litchfield International.
 B. Vibration isolation pipe clamp, yellow zinc chromate finish, B-Line BVT Series Vibraclamp or Kwik-Clip by B-Line.

2.014 FIXTURE SUPPLY SUPPORT

- A. Galvanized steel stud support bracket, pre-drilled tube support mounting holes, adjustable stud width, Erico TSGB or equal.
- B. UV resistant nylon tube support, rated for 0°F through 130°F, resealable locking mechanism, Erico TPC or equal.
- C. Support bracket and tube support to be from same manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install supports to allow for free expansion of piping. Support piping from building structural members using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. At no time shall hangers and supports overload building structural members. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.
- B. Select and size building attachments properly in accordance with MSS Standards and manufacturer's published load rating information.
- C. Coordinate hanger and support installation to properly group piping of all trades.
- D. Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.
- E. Piping and ductwork shall be supported independently from other piping or ductwork.
- F. Pipe hangers and supports shall not penetrate vapor barrier of pipe insulation.
- G. Do not support equipment, piping or ductwork from metal roof decking or ceiling grid.
- H. Install adequate supports so as not to over stress either piping or equipment to which piping is connected.
- I. Refer to Section 20 0000 - General Mechanical Requirements for requirements of personnel injury protection guards for supporting devices.

3.02 HANGER AND SUPPORT SPACING - HORIZONTAL PIPE

- A. Space pipe hangers and supports for horizontal pipe accordance with the following schedule, with exceptions as indicated herein:
- B. Steel Pipe (Standard Weight and Extra Strong) (Unless Otherwise Noted):

<u>Pipe Size</u>	<u>Max Spacing</u>
1-1/4" and smaller	7'-0"
1-1/2"	9'-0"
2"	10'-0"
2-1/2"	11'-0"
3"	12'-0"
4"	4.2 m(14'-0")

- C. `Steel Pipe (Fire Protection Sprinkler): Support piping in accordance with NFPA 13.
- D. Copper Tube (Unless Otherwise Noted):

<u>Pipe Size</u>	<u>Max Spacing</u>
19 mm(3/4" and smaller)	1.5 m(5'-0")
1" to 1-1/4"	6'-0"
1-1/2" to 2-1/2"	8'-0"
3" and larger	10'-0"

- E. Copper Tube (Domestic Water, Non-potable Water):

<u>Pipe Size</u>	<u>Max Spacing</u>
1-1/4" and smaller	6'-0"

- 1-1/2" and larger 10'-0"
- F. Plastic Pipe
1. PVC Pipe:

<u>Pipe Size</u>	<u>Max Spacing</u>
All sizes	4'-0"

2. Support plastic pipe at all changes of direction. Adequate consideration shall be given to piping expansion.
- G. Cast Iron Pipe:
1. Maximum hanger and support spacing shall be 10 ft for all pipe sizes. Provide minimum of one hanger per pipe section close to joint on barrel, at each pipe fitting, at change of direction and branch connections.
2. Support Cast Iron No-Hub pipe as recommended in CISPI Publication "Cast Iron Soil Pipe and Fittings Handbook, Chapter IV - Installation of Cast Iron Soil Pipe and Fittings."
- H. Maximum spacing shown above may be restricted by strength of attachment to building structure. Submit data with calculations with published load ratings showing attachment to be utilized and maximum spacing allowable for that type of attachment and pipe size.
- I. Spacing less than indicated above may be required to conform to building structure design or loading limitations.
- J. If pipe size changes between support points, maximum spacing shall be based on the smaller pipe size.
- K. If trapeze hangers are used to support multiple services, spacing shall be based on the most restrictive pipe size and material on trapeze hanger.
- L. For non-metallic pipe, follow manufacturer's installation recommendations in addition to requirements noted herein.
- M. Install supports for vertical piping and anchors as recommended by pipe manufacturer.
- N. Place hangers and supports to meet requirements of Section 23 2116 - Pipe and Pipe Fittings or specific pipe system sections, with regard to pitch for drainage and venting and clearance between services.
- O. Hangers and supports shall bear on outside of insulation when pipes are to be insulated.
- P. Place hangers and supports within 1 ft of each fitting, such as elbows and tees, and at each valve, strainer, and other piping specialty for piping 4" and larger.
- Q. Place hanger or support at first elbow upstream of pump inlet and first elbow downstream of pump outlet.

3.03 RISER SUPPORTS

- A. Insulated Piping and non-insulated piping (120°F and above):
1. Unless otherwise indicated, support vertical piping as indicated below:
2. Support vertical piping at bottom of riser, secured and anchored to building structure. Provide guides on vertical piping. Use spring hangers at top of riser and at take offs from riser at each floor. Use spring hangers for minimum 3 hangers away from top and bottom elbows and from each take off at riser.
3. Guide vertical piping 2" and smaller at every floor. Guide 2-1/2" and larger at every other floor. Spring hangers (Type 6) and guides (Type VSG) are specified in Section 23 0550 - Vibration Isolation.
- B. Ambient Bare Piping:
1. Unless otherwise indicated, maximum vertical support spacing for ambient bare steel and cast iron pipes shall be 15 ft.
2. Maximum vertical support spacing for other piping including copper tubing and plastic piping shall be 10 ft.

3. Install riser clamps and intermediate supports as required.
4. Rest riser clamps on floor or on pipe sleeve.

3.04 INSULATION PROTECTION SHIELDS

- A. Install insulation protection shields at support points as specified under Insulated Pipe Supports.
 1. Use one shield (bottom) for clevis hanger.
 2. Use 2 shields (top and bottom) for roller hanger/support or strap/clamp support. Apply 2 metal straps to hold top and bottom shields onto insulation jacket.

3.05 INSULATED PIPE SUPPORTS

- A. Install insulated pipe support at each support point of insulated pipe. Provide insulation protection shields except where saddles are used.
- B. Pipe Size 1-1/2" and Smaller:
 1. Use insulation protection shields. Pipe insulation specified in Section 20 0700 - Mechanical Systems Insulation shall be continuous through support points.
- C. Pipe Size 2" and Larger:
 1. Use pre-insulated pipe supports. Refer to Part 2 for acceptable products.
 2. In lieu of pre-insulated pipe supports, field-assembled insulated pipe supports may be used. If used, submit application details including materials, thickness, compression strength, load bearing surfaces, load calculations of support assembly and total pipe weight based on support spacing.
 3. Field-assembled insulated pipe supports shall consist of weight bearing insulation inserts and insulation protection shields.
 4. Insulation protection saddles may be used in lieu of assembled insulated pipe supports on roller hangers/supports for hot water pipes, low pressure steam and steam condensate pipes.

3.06 TRAPEZE SUPPORTS

- A. Construct trapeze supports with struts, angles, or channels and hang them by inserts or welded beam attachments and rods.
- B. Determine trapeze supports spacing by the smallest pipe on trapeze.

3.07 CONCRETE ANCHORS

- A. Anchor application, size, and placement shall be reviewed and approved by Structural Engineer prior to installation.

END OF SECTION

**SECTION 200553
MECHANICAL SYSTEMS IDENTIFICATION**

PART 1 - GENERAL

1.01 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.02 SUBMITTALS

- A. Product Data: For identification materials and devices
B. Valve Schedules: For each piping system

PART 2 - PRODUCTS

2.01 IDENTIFYING DEVICES

- A. Painted Identification System:
1. Stencils:
 - a. Standard fiberboard stencils, prepared for required applications.
 - b. Letter sizes complying with ANSI A13.1 for piping and similar applications
 - c. Not less than 1-1/4" high letters for ductwork.
 - d. Not less than 3/4" high letters for access door signs and similar operational instructions.
 2. Stencil Paint:
 - a. Standard exterior type stenciling paint, oil-based, alkyd enamel.
 - b. Black color, except as otherwise indicated.
 - c. Either brushing grade or pressurized spray-can form and grade.
 3. Identification Paint:
 - a. Standard identification enamel.
- B. Marker System:
1. Manufacturers: Brady USA, Marking Services Inc. (MSI), Kolbi, or Seton
 2. Manufacturer's standard, preprinted with color coding, lettering size and length of color field according to ASME A13.1.
 3. Use pressure-sensitive type or "snap-on" type.
 4. "Strap-on" type may be used for piping over 6" size including insulation.
 5. Arrows: Each pipe marker shall have arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.
 6. Dimensions:
 - a. 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6 inch.
 - b. 2-1/2" wide tape markers for on pipes with outside diameters (including insulation, if any) of 6 inch or greater.
- C. Valve Tags:
1. Minimum 1-1/2" diameter, 0.032" thick, polished brass or 316 stainless steel.
 2. Stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high.
 3. Provide a printed and framed valve tag schedule that is to be installed in the main mechanical room.
- D. Laminated Plastic Nameplates:
1. Engraving stock melamine plastic laminate, in the sizes and thickness indicated, engraved with engravers standard letter style of the sizes and wording indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 2. Nameplates shall be approximately 1-1/2" x 4", 1/16" thick, and have 1/2" high lettering. Face of plastic nameplates shall be black with white letters.

3. Fasteners shall be self-tapping, stainless steel screws or contact type with permanent adhesive.

PART 3 - EXECUTION

3.01 GENERAL

- A. After painting of all exposed mechanical pipe systems and/or covering is completed, identify equipment and piping as indicated. Locate identification as conspicuously as possible except where such would distract from finished area.
- B. Where markers are used in high heat applications or exposed to harsh chemical or acid environments, specifically select marker materials for those applications.
- C. Identification shall be installed prior to installation of acoustical ceilings and similar removable concealment.

3.02 DUCTWORK IDENTIFICATION

- A. Identify air supply, return, exhaust, intake, and relief ductwork with stenciled signs and arrows.
- B. Show ductwork service and direction of flow in black and white, and indicate what unit the ductwork either comes from or goes to.
- C. Locations:
 1. Provide identification in each space where ductwork is exposed, or concealed only by removable ceiling system.
 2. Provide identification near points where ductwork originates or continues into concealed enclosures.
 3. Provide identification at 50 foot intervals along exposed runs.
- D. Duct Access Doors: Stenciled signs on each access door in ductwork and housings, indicating purpose of access (to what equipment item).

3.03 PIPING SYSTEM IDENTIFICATION

- A. Install pipe identification on each system. Place flow directional arrows at each pipe identification location.
- B. Locate pipe identification as follows:
 1. On piping exposed to view in occupied spaces, machine rooms, accessible maintenance spaces and exterior non-concealed locations.
 2. Near each valve and control device.
 3. At each branch, excluding short take-offs for fixtures and terminal units.
 4. Near locations where exposed pipes pass through walls, floors, ceilings, or enter non-accessible enclosures.
 5. At access doors or panels, manholes and similar access points which permit view of concealed piping.
 6. Near major equipment items and other points of piping origination and termination.
 7. On piping above removable acoustical ceilings.
 8. Not less than once in each room.
 9. Not less than once every 25 feet.
- C. Identify piping with marker system.
 1. For "strap-on" type, ensure marker is fitted snugly to pipe or pipe insulation surface with sufficient straps.

3.04 VALVE IDENTIFICATION

- A. Identify valves with brass tags bearing system identification and valve sequence number in 1/2" black characters. Attach tag to valve body with brass jack chain and "S" hook for brass tag and SS jack chain or SS braided wires with swag sleeves and "S" hook for stainless steel tag. Non-metallic fasteners are not allowed.
- B. Valve numbers shall be prefixed with corresponding piping system identification in 1/4" black letters.

- C. Valve tags are not required at terminal devices unless valves are greater than 10 ft from device or located in another room not visible from terminal unit.
- D. Furnish typewritten valve schedule indicating valve number, fixtures, equipment or areas served by each numbered valve and incorporate in O&M Manuals.

3.05 EQUIPMENT IDENTIFICATION

- A. Identify major equipment, including fan coil units, fans, air terminal devices, pumps, water heaters, tanks, compressors, etc.
- B. Identify equipment with laminated plastic nameplates.
- C. Identify control equipment and panels with laminated plastic nameplates.
- D. Indicate the area that equipment serves by zone(s) or room number(s).
- E. Identify the following general categories of equipment and operational devices:
 - 1. Main control and operating valves, including safety devices.
 - 2. Meters, gauges, thermometers and similar units.
 - 3. Fuel-burning units including boilers, furnaces, and heaters.
 - 4. Pumps, compressors, chillers, condensers and similar motor-driven units.
 - 5. Heat exchangers, coils, evaporators, cooling towers, heat recovery units and similar equipment.
 - 6. Exhaust fans, fans, blowers, primary balancing dampers and VAV boxes.
 - 7. HVAC central-station and zone-type units.
 - 8. Tanks and pressure vessels.
 - 9. Air conditioning indoor and outdoor units.
 - 10. VFDs and transmitters and Control Boxes.
 - 11. Domestic water heaters.
- F. Nameplate Markings:
 - 1. Identify model number, size, capacity, electrical characteristics, serial number, along with other items scheduled for equipment on drawings.
 - 2. Indicate motor horsepower, voltage, phase, cycles, RPM, full load amps, locked motor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor, efficiency, minimum circuit amps, minimum feeder conductor size, disconnect or fuse size, refrigerant, and other pertinent information.
 - 3. Refer to NFPA-70 (NEC), Articles 110.21, 422.60, 422.61, 422.62, 424.28, 424.29, and 424.86.
- G. Locate motor nameplates for easy reading. Relocate or provide new nameplates on motors if original nameplates are not located for easy reading.

3.06 FIELD CONTROL DEVICE IDENTIFICATION

- A. Identify control equipment, panels, and field control devices with Laminated Plastic Nameplates.
- B. Nameplate:
 - 1. Approximately 2" x ¾" size.
 - 2. White with black letters.
 - 3. Engraved with the name of the device as described in the BAS software.
- C. For exposed devices, nameplate shall be located on or near the device.
- D. For concealed devices, nameplate shall be affixed in an exposed location to allow maintenance personnel to determine the location of the device without removing the concealing material.
- E. If several small devices are located on one concealed unit, only the main unit need be identified with an exposed nameplate.
- F. The following devices shall be so labeled:
 - 1. Temperature Elements: XXX-TMP
 - 2. VAV Boxes and Lab Air Valves: XXX-VAV
 - 3. VAV Controllers (if remote from box): XXX-VAV Cont
 - 4. Static Pressure Transmitters: AHU-XX SP

5. Discharge Air Temp Transmitters: AHU-XX Zone ZZ DAT

3.07 ACCESS PANEL IDENTIFICATION

- A. Furnish typewritten charts with identification and location of all access panels serving equipment and valves and incorporate in O&M Manuals.

END OF SECTION

**SECTION 200700
MECHANICAL SYSTEMS INSULATION**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 20 0000 - General Mechanical Requirements
- B. Section 20 0529 - Mechanical Supporting Devices

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 DESCRIPTION

- A. Provide insulating materials and accessories as required for mechanical systems as specified below.
- B. Insulating products delivered to construction site shall be labeled with manufacturer's name and description of materials.

1.04 DEFINITIONS

- A. Concealed areas, where indicated in this Section, shall apply to shafts, furred spaces and space above finished ceilings, inaccessible tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.
- B. Unless otherwise indicated, unit of thermal conductivity is Btu·in/(h·ft²·°F).
- C. Interstitial spaces are considered as concealed areas.

1.05 SUBMITTALS

- A. Shop Drawings for each piping system for all pipe sizes, each ductwork system, and all equipment including, but not limited to, the following:
 - 1. Manufacturer's name
 - 2. Schedule of insulating materials
 - 3. Insulation material and thickness
 - 4. Jacket
 - 5. Adhesives
 - 6. Fastening methods
 - 7. Fitting materials
 - 8. Intended use of each material
 - 9. Manufacturer's data sheets indicating density, thermal characteristics, temperature ratings
 - 10. Insulation installation details (manufacturer's installation instruction/details, Contractor's installation details, MICA plates where applicable)
 - 11. Literature data sheet from sealants and adhesive manufacturers stating VOC compliance with USGBC LEED IEQ 4.1.
 - 12. Literature data sheet from coatings and mastics (including lagging adhesives) manufacturers stating VOC compliance with USGBC LEED IEQ 4.2.
 - 13. All other appropriate data

1.06 DELIVERY, STORAGE AND HANDLING

- A. Insulation material shall be delivered to project site in original, unbroken factory packaging labeled with product designation and thickness. Shipment of materials from manufacturer to installation location shall be in weather-tight transportation. Protect insulation materials from moisture and weather during storage and installation. Protect insulation material against long exposure to UV light from sun.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Owens Corning, Johns Manville, Knauf or CertainTeed similar to product indicated except where product of manufacturers not listed above is specifically identified for special type of insulation.
- B. Coatings, Mastics, Sealants and Adhesives: Foster, Childers, Vimasco, Miracle or Pittsburgh Corning

2.02 MATERIALS

- A. Products used for or related to air conditioning and ventilating systems shall conform to NFPA 90A possessing flame spread rating of not over 25 and smoke developed rating no higher than 50.
- B. Unless otherwise indicated, all products, material itself or on a composite basis, shall meet ASTM E-84, UL 723 or NFPA 255 and shall not exceed 25 flame spread and 50 smoke developed.
- C. Outdoor insulation may have flame spread rating up to 75 and smoke developed rating up to 150.
- D. Insulation applied on stainless steel shall meet requirements of ASTM C795 and NRC 1.36.

2.03 INSULATION

- A. Insulation materials shall be fire retardant, moisture and mildew resistant, vermin proof, and suitable to receive jackets, adhesives and coatings as indicated.
- B. Glass fiber insulation shall be of inert inorganic material, non-corrosive to mechanical surfaces.
- C. Insulating cement shall be Quick-Cote by PK Insulation MFG Co. or Ryder GP, with dry density of no more than 38 lb/ft³ thermal conductivity of 0.96 at 400°F mean temperature, and service temperature to 1200°F.
- D. Filling and finishing cement shall be Super-Stik by PK Insulation MFG Co., or Ryder MW, with dry density of no more than 24 lb/ft³, thermal conductivity of 0.74 at 500°F mean temperature, and service temperature to 1900°F.
- E. Type A Insulation (Closed Cell Elastomeric Thermal Insulation):
 - 1. Minimum nominal density of 6 lb/ft³, thermal conductivity not more than 0.28 at 75°F mean temperature, maximum water vapor transmission of 0.08 perm-inch and suitable for temperatures from -70 to 220°F, Armacell Model AP/Armaflex, K-Flex USA, or Aeroflex Model Aerocel.
- F. Type F Insulation (Flexible Glass Fiber):
 - 1. Minimum density of 0.75 lb/ft³ with thermal conductivity of not more than 0.29 at 75°F mean temperature, and suitable for temperatures to 250°F. Owens Corning "All Service Duct Wrap", Johns Manville Microlite. Minimum R value 4.2.
- G. Type G Insulation (Cellular Glass):
 - 1. 100% cellular glass cells with no organic material, noncombustible, 0.00 perm-inch permeability, 7.5 lb/ft³ average density, compression strength 90 psi, thermal conductivity of not more than 0.31 at 50°F mean temperature and service temperature of 900°F. Pittsburgh Corning Foamglas or approved equal.
- H. Type H Insulation (High Temperature Block or Pipe):
 - 1. Hydrous calcium silicate, suitable for temperatures to 1200°F, thermal conductivity not more than 0.50 at 400°F, dry density 13 lb/ft³ minimum and compressive strength 100 psi, Industrial Insulation Group (formerly Johns Manville), Thermo-12 Gold.
- I. Type R Insulation (Rigid Glass Fiber):
 - 1. Minimum nominal density of 3 lb/ft³ with thermal conductivity of not more than 0.23 at 75°F mean temperature. Minimum compressive strength at 10% deformation shall be 25 lb/ft².
 - 2. Pipe insulation shall be suitable for temperatures to 850°F, Johns Manville Micro-Lok 850, Owens Corning Fiberglas ASJ/SSL-II.
 - 3. Duct and equipment insulation shall be suitable for temperatures to 450°F, Johns Manville Spin-Glas Type 814, Owens Corning Type 703. Minimum R value 4.2.

4. Pipe and tank wrap faced with specified jacket may be used for equipment and round ducts insulation, provided that it meets all insulation characteristics requirements stated above and maintains same R-value as specified.
- J. Type RR Insulation (Rigid Glass Fiber):
1. Minimum nominal density of 6 lb/ft³ with thermal conductivity of not more than 0.22 at 75°F mean temperature. Insulation shall be suitable for temperatures to 450°F. Minimum compressive strength at 10% deformation shall be 200 lb/ft², Johns Manville Spin-Glas Type 817 or Owens Corning 705.
 2. TUFF-R Polyisocyanurate Insulation by Celotex may be used for Type RR insulation specified for exterior rectangular ductwork, provided minimum thickness is 3/4" and R-value is not less than R-value specified.
 3. Pipe and tank wrap faced with specified jacket may be used for equipment and round duct insulation, provided that it meets all insulation characteristics requirements stated above and maintains same R-value as specified.

2.04 JACKETS

- A. Jacket puncture resistances shall be based on ASTM D-781 test methods. Vapor barrier permeance ratings shall be based on ASTM E-96 Procedure A.
- B. Type D-1 Jacket:
1. Heavy-duty, fire retardant material with glass fiber reinforcing. Jackets shall have neat, white Kraft finish or white vinyl finish suitable for painting, with beach puncture resistance of 50 units minimum. Vapor barrier shall be adhered to inner surface of jacket. Permeance shall not exceed 0.02 perm. Owens Corning "ASJ", Johns Manville "AP".
- C. Type D-2 Jacket:
1. Glass fiber reinforced foil Kraft laminate with permeance not exceeding 0.02 perm and beach puncture resistance 25 units minimum. Owens Corning "FRK", Johns Manville "FSK".
- D. Type P-1 Jackets:
1. Heavy-duty, fire retardant material with glass fiber reinforcing and self-sealing lap. Jacket shall have neat, white Kraft finish or white vinyl finish suitable for painting, with beach puncture resistance of 50 units minimum. Vapor barrier shall be adhered to inner surface of jacket. Permeance shall not exceed 0.02 perm. Owens Corning "ASJ-SSL", Johns Manville flame-safe "AP-T".
- E. Type V-1 Jacket:
1. Fire retardant and UV resistant PVC in minimum 20 mil (0.02") thickness consisting of preformed fitting covers, preformed end terminations, and sheet material for straight runs of pipe. Material when installed according to manufacturer's instructions shall provide complete vapor barrier and readily cleanable surface while meeting Federal CGMP requirements.
 2. Jacketing system shall be equal to Johns Manville Zeston/Perma-Weld System. Similar product by PROTO will be acceptable.

2.05 ADHESIVES, MASTIC, COATINGS, SEALANTS, AND REINFORCING MATERIALS

- A. Products shall be compatible with surfaces and materials on which they are applied, and shall be suitable for use at operating temperatures of systems to which they are applied.
- B. Products shall be fire retardant, moisture resistant and mildew resistant and vermin proof.
- C. Adhesives, mastic, sealants, and protective finishes shall be as recommended by insulation manufacturer for specified application.
- D. Adhesives, mastic, sealants, and protective finishes, shall comply with VOC limits set forth in South Coast Air Quality Management District (SCAQMD) Rule 1168.
- E. Glass fiber fabric reinforcing shall be 10 x 10 or 20 x 10 mesh.
- F. Wire mesh reinforcing shall be 22 ga, 1" galvanized.

- G. Insulation cement shall be ANSI/ASTM C195, hydraulic setting mineral wool.
- H. Finishing cement shall be ASTM C449.
- I. Butt joint and longitudinal joint adhesive for Type A insulation shall be Armstrong 520, Rubatex 373 or Manville 57.
- J. Weather-resistant protective finish for Type A insulation shall be equal to Armstrong WB Armaflex finish.

2.06 METAL BANDS AND WIRES

- A. Aluminum bands shall be 0.5" x 0.020" up to 48" diameter and 0.75" x 0.020" over 48" diameter.
- B. Stainless steel bands shall be 0.5" x 0.015" or 0.75" x 0.015".
- C. Stainless steel wires shall be 16 ga.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Provide insulation and jackets as indicated in the following schedule. The schedule applies to both exposed and concealed applications unless noted otherwise:

<u>Service</u>	<u>Jacket Type</u>	<u>Insulation Type</u>	<u>Insulation Thickness According to Pipe Size</u>				
			<u>3/4" and less</u>	<u>1" - 1-1/4"</u>	<u>1-1/2" - 3"</u>	<u>4" - 6"</u>	<u>8" and Larger</u>
Cooling Coil Condensate Drain	--	A	3/4"	3/4"	3/4"	3/4"	3/4"
Refrigerant Suction Lines and Hot Gas By-pass Line if Used	-	A	1"	1"	1"	1"	1"
Provide protective coating paint for exposed exterior piping.							
Heating Hot Water (to 200F)	P-1	R	1-1/2"	1-1/2"	2"	2"	2"
Domestic Potable Hot Water and Hot Water Return (105-140°F)	P-1	R	1"	1"	1-1/2"	1-1/2"	1-1/2"
	--	A	1"	1"	1-1/2"	NA	NA

Exposed piping in spaces with finished floors or ceilings. Provide V-1 jacket in addition to insulation jacket specified in this schedule.

<u>Service</u>	<u>Jacket Type</u>	<u>Insulation Type</u>	<u>Insulation Thickness According to Pipe Size</u>				<u>8" and Larger</u>
			<u>3/4" and less</u>	<u>1" - 1-1/4"</u>	<u>1-1/2" - 3"</u>	<u>4" - 6"</u>	
Piping Penetrating Through Roof.							

Provide Type 1" thick Type R insulation between pipe and roof flashing.

<u>Service</u>	<u>Ductwork/Equipment System</u>		
	<u>Jacket Type</u>	<u>Insulation Type</u>	<u>Insulation Thickness</u>
OA Ducts Exposed	D-1 or D-2	R	2"

<u>Service</u>	<u>Ductwork/Equipment System</u>		
	<u>Jacket Type</u>	<u>Insulation Type</u>	<u>Insulation Thickness</u>
OA Ducts Concealed	D-2	F	2"
Mixed Air (Outside Air & Return Air Ducts & Plenum)	D-1	R	1-1/2"
Supply & Return Ducts Exposed	D-1	R	1-1/2"
Supply, Return and General Exhaust Ducts Concealed	D-2	F	2"
Fume Exhaust and Restroom Exhaust Ducts	n/a	NONE	n/a

3.02 INSTALLATION - GENERAL

- A. All insulation installation methods shall be performed in accordance with the latest edition of National Commercial and Industrial Insulation Standards published by MICA (Midwest Insulation Contractors Association) and manufacturer's installation instructions, except as modified in this Section of specifications.
- B. Install products with good workmanship, with smooth and even surfaces. Use full-length factory-furnished material where possible. Do not use scrap pieces.
- C. Apply insulation only on clean, dry surfaces, after all rust and scale have been removed and testing of systems has been completed. Do not insulate any section of system that must be pressure tested until after it has been successfully tested. Any removal and reinstallation to correct system defects prior to end of guarantee period shall be accomplished at no expense to Owner.
- D. Install insulating materials with necessary joints and terminations, to permit easy access and removal of equipment sections where inspection, service or repair is required, and to allow for expansion.
- E. Where possible longitudinal joints in jackets shall face toward wall or ceiling.
- F. Apply insulation to each pipe or duct individually. Common insulation applied to adjacent pipes or ducts will not be accepted.
- G. Unless otherwise indicated, pipe and duct insulation shall be continuous through walls and floors.
- H. Where multiple layers of insulation are used, stagger and secure each layer with metal bands.
- I. Where penetrations occur through fire-rated walls, partitions, or floors, provide fire seal as specified in Section 20 0000 - General Mechanical Requirements and Section 20 0573 - Mechanical Systems Firestopping.
- J. Insulate water piping within casework up to penetration of casework pipe chase at fixture stop. Insulate water piping within walls up to pipe penetration through the wall at fixture stop when serving wall-mounted fixtures. Termination of insulation shall be in neat and workman like manner with insulation jacket cap.
- K. Insulate the following systems for complete vapor barrier protection:
 1. Refrigerant
 2. Cooling coil condensate drain
 3. All insulated ductwork
- L. Apply Type A insulation for insulation and jackets requiring vapor barrier protection where specified insulations are cut for mounting sensors, control devices, parts of valves, devices or components which extend out from specified insulation to prevent condensation.

3.03 PIPING, VALVE AND FITTING INSULATION

- A. Apply insulation to pipe, unions, flanges, fittings, valves and piping specialties with butt joints and longitudinal seams closed tightly. Valve insulation shall cover entire valve body including bonnets and packing nuts.

- B. Laps on factory-applied jackets shall be 2" minimum width firmly cemented with lap adhesive, or shall be pressure sealing type lap.
- C. Cover joints with factory furnished tape (3" minimum width) to match jacket. Cement firmly with lap adhesive.
- D. Secure insulation, except insulation covered with vinyl jackets, additionally with staples.
- E. Where staples are used, they shall be on 6" maximum centers. When used for systems requiring vapor barrier, cover lap and staples with finish coat of lagging adhesive.
- F. Built-up insulation for fittings and valves shall be made with sectional insulation, wrapped firmly to thickness of adjoining pipe insulation, and bound with jute twine, or built up with insulating cement, and finished to smooth hard surface, and covered with minimum of 9 oz per sq yd rewettable glass cloth similar to Clairmont Diplag 60.
- G. For valves and fittings requiring vapor barrier, apply 2 coats of vapor barrier mastic with glass fiber reinforcing fabric after application of insulating cement. For valves and fittings not requiring vapor barrier, apply 2 coats of weatherproof mastic with glass fiber reinforcing fabric after application of insulating cement. Apply coating in accordance with manufacturer's recommended procedure.
- H. For finishing of insulated pipe fittings and valves where surface temperature of insulation is not higher than 125°F, one piece PVC fitting covers, minimum thickness of 20 mil, may be used. Fitting covers located in mechanical rooms within 8 ft above floor shall be 30 mil thickness. Johns Manville Zeston 2000 PVC, PROTO Fitting Covers, or similar by other manufacturers listed. Where fitting and valve insulation requires vapor barrier, seal joints of PVC covers with vapor barrier adhesives. Insulation type, R-value and density of insulation used at fittings shall match those of adjacent piping. Install insulation at pipe fittings and valves completely prior to applying PVC covers.
- I. Where terminations of pipe insulation are required, insulation shall have tapered ends, built up and finished as specified for fittings.
- J. For pipes 1-1/2" and smaller, install specified pipe insulation and jacket continuous through hanger or support locations. Install insulation protection shields to protect insulation from compressing.
- K. For pipes 2" and larger, where manufactured pre-insulated pipe supports are used at hanger or support locations, extend insulation to insulated pipe supports. Where vapor barrier is required, this Contractor shall be responsible for continuity of vapor barrier at insulated pipe supports. Use 3" wide vapor barrier tape on hot and cold systems at pipe supports.
- L. For pre-insulated pipe supports and insulation protection shields, refer to Section 20 0529 - Mechanical Supporting Devices.
- M. For Contractor-fabricated anchors, secure insulation directly to pipe surface and extend insulation up anchor for distance of 4 times insulation thickness. For pre-insulated anchors, cover entire surface of anchors with Type A insulation. Where applicable, take special care to assure vapor seal at anchor.
- N. Where mechanical grooved pipe connections are used in piping system, insulate couplings as specified for pipe.
- O. Piping, fittings and valves not to be insulated:
 - 1. Valves furnished with removable insulation/jacket

3.04 DUCTWORK AND COMPONENTS

- A. Apply duct insulation evenly over duct surface. Unless otherwise indicated, insulation and jacket shall run continuously between duct and duct supports. Maintain insulation thickness specified over duct reinforcing members.
- B. For support points of rectangular or oval ducts supported by trapeze hangers, place weight-supporting insulation at bottom of duct over trapeze. Weight supporting insulation inserts shall be minimum 6" long with same thickness as insulation specified and shall be Type G or H insulation. Size inserts based on compression strength and weight being supported.

- C. For support points of round ducts smaller than 16" diameter, weight-supporting insulation is not required for either rigid or flexible glass fiber insulation.
- D. For support points of round ducts 16" diameter and larger, place weight-supporting insulation between duct and strap or trapeze. Weight-supporting insulation shall be minimum 6" long with same thickness as insulation specified and shall be Type G or H insulation. Size inserts based on compression strength and weight being supported.
- E. Secure flexible glass fiber insulation (Type F) to underside of horizontal rectangular or oval ductwork 24" in width or greater and on vertical sides of horizontal and vertical ductwork with weld pin fasteners not over 18" on center and within 3" of butt joint or edge.
- F. Secure rigid glass fiber insulation (Type R) to all sides of horizontal and vertical rectangular or oval ductwork with weld pin fasteners. Install pins or fasteners as required to secure, but not less than 12" on center for underside and sides of ducts and 24" on center for top of ducts, and within 3" of butt joint or edge.
- G. Clip pins fastened to ductwork with adhesives are not allowed. Where weld pin fasteners are used, install them without damage to interior galvanized surface. Clip pins neatly back to each fastener.
- H. Where insulation is required for ductwork, provide insulation over entire ductwork system, including system components such as filters, mixing air chambers, sound attenuators, air measuring stations, reheat coils, etc. For fire dampers, smoke dampers and combination F/S dampers in ductwork requiring insulation, install insulation and jacket to wall and apply vapor barrier sealant to prevent condensation.
- I. Provide insulation over supply air diffusers, grilles and unlined boots after termination point of flexible ducts or rigid duct insulation to prevent from sweating.
- J. Where vapor barrier jackets are specified, pins shall be jacketed over with matching material. Where staples are used for systems requiring vapor barrier, cover lap and staples with finish coat of lagging adhesive.
- K. Insulation without factory jacket shall be cut and mitered to suit surface. Build up voids, seams and joints with insulating cement, cover with glass fabric as specified herein and finish to smooth surface.
- L. For other than factory-applied vapor barrier jackets, apply 2 coats of vapor barrier mastic with glass fiber reinforcing fabric, after application of insulating cement. For surfaces not requiring vapor barrier jackets, apply 2 coats of weatherproof mastic with glass fiber reinforcing fabric after application of insulation cement. Apply coating in accordance with manufacturer's recommended procedure.
- M. D-1 jackets:
 - 1. Butt together joints and seams firmly.
 - 2. Cover all joints, seams, punctures and breaks in jacket with glass fiber fabric, 4" minimum width, and finish with 2 coats of vapor barrier mastic.
- N. D-2 jackets:
 - 1. Butt together joints and seams firmly.
 - 2. Cover all joints, seams, punctures and breaks in jacket with glass fiber fabric, 4" minimum width, and finish with 2 coats of vapor barrier mastic.

3.05 PROTECTIVE INSULATION SHIELD (A-1 JACKET) FOR PIPE JACKETS EXTERIOR TO BUILDING

- A. Longitudinal overlap shall be at least 2" wide with vapor barrier sealant.
- B. Secure jacketing with 3/4" wide 0.015" stainless steel or 3/4" wide 0.020" aluminum bands and wing seals on maximum 18" centers.

END OF SECTION

SECTION 21 1314
AUTOMATIC FIRE SPRINKLER SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies materials and methods for the following systems.
 - 1. Sprinkler
- B. Extend piping to 5 feet outside the building wall and connect to the site fire system.
- C. Research indicates there is no documentation or indication that microbiologically influenced corrosion (MIC) exists in the area of the project.
- D. NFPA 13's seismic requirements are not part of this project.
- E. This is not a Factory Mutual Global (FMG) protected property.
- F. Engineer of Record:
 - 1. This is a performance-based specification. Affiliated Engineers is the Engineer of Record.
 - a. The Engineer has prepared Signed-and-Sealed Drawings and Specifications.
 - b. Provide engineering design, system layout, and hydraulic calculations.
 - c. Do not Sign-and-Seal fabrication drawings or hydraulic calculations.
 - d. The Contract Documents establish the requirements and parameters for system design and installation.

1.02 RELATED WORK

- A. Section 20 0000 - General Mechanical Requirements
- B. Section 20 0520 - Excavation and Backfill
- C. Section 20 0529 - Mechanical Supporting Devices
- D. Section 20 0553 - Mechanical Systems Identification
- E. Section 20 0573 - Mechanical Systems Firestopping
- F. Section 28 3116 - Multiplexed Fire Detection and Alarm Systems

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. This installation shall conform to the following:
 - a. NFPA 13, Installation of Sprinkler Systems (2016 Edition)
 - b. NFPA 24, Installation of Private Fire Service Mains and Their Appurtenances (2016 Edition)
 - c. NFPA 45, Fire Protection for Laboratories Using Chemicals (2015 Edition)
 - d. NFPA 72, National Fire Alarm Code (2016 Edition)
 - e. NFPA 101, Life Safety Code (2018 Edition)
 - f. Underwriters Laboratories (UL) Fire Protection Equipment Directory
 - g. Florida Building Code (2020 Edition)
- B. Contractor Installation Program:
 - 1. Provide journeyman sprinkler fitter(s) for installation and supervision.
 - 2. Provide fire protection installer licensed in the State of Florida for installation of fire protection systems.
 - 3. Submit pre-qualification evidence of at least three projects of comparable size successfully completed with their Bid.
- C. Electrical Coordination
 - 1. All relays, wire, conduit, pushbuttons, pilot lights, and other devices required for power side or the control of electrical equipment shall be furnished by Division 26 and Division 28 Contractors, except as specifically noted elsewhere in this Specification.
 - 2. Should any change in electrical equipment size, horsepower rating, or means of control be made to any motor or other electrical equipment after contracts are awarded, Division 21

Contractor is to immediately notify Division 26 and Division 28 Contractors of this change and pay any costs due to this change.

3. Division 26 Contractors shall provide all power wiring and Division 21 Contractor shall be responsible for providing all control wiring and its conduit. Control wiring shall conform to Division 26 and 28 requirements for control wiring.
4. Furnish wiring diagrams to Division 26 and Division 28 Contractors for equipment and devices furnished by Division 21 Contractor which have been indicated to be wired by Division 26 and Division 28 Contractors.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site under provisions of Division 01.
- B. Store and protect products under provisions of Division 01.
- C. All materials shall be stored in a clean, dry space.
- D. Promptly inspect shipments to insure material is undamaged and complies with Specifications. Storage and protection methods must allow inspection to verify products.
- E. Furnish pipe with plastic end-caps/plugs on each end of pipe. Maintain end-caps/plugs through shipping, storage and handling, and installation to prevent pipe-end damage and to eliminate dirt and construction debris from accumulating inside of pipe. Protect fittings and unions by storage inside or by durable, waterproof, aboveground packaging.
- F. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade.
- G. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

1.05 SUBMITTALS

- A. Pre-qualification documents
- B. Product Data:
 1. Pipe
 2. Valves
 3. Tamper switches
 4. Flow switches
 5. Sprinklers
 6. Fire department connections
 7. Pressure gauges
 8. Material Safety Data Sheet (MSDS) for corrosion inhibitive paint
- C. Shop Drawings:
 1. Fabrication Drawings
- D. Calculations:
 1. Hydraulic Calculations
- E. Submit to Local Authority for Review:
 1. Product data sheets
 2. Fabrication drawings
 3. Hydraulic calculations
- F. Review Letters:
 1. Local Authority review letter
- G. Reports:
 1. Pipe Pressure Test Reports
- H. Certifications:
 1. NFPA Exterior Piping Certifications
 2. NFPA Sprinkler Certifications
 3. Performance testing for double check backflow preventer assembly.
- I. Closeout Documents:

1. NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials and Equipment:
 1. Materials and equipment in system shall be new and current products of manufacturer regularly engaged in production of such materials and equipment.
 2. Where two or more pieces of equipment are required to perform interrelated functions, they shall be products of same manufacturer.
- B. Approval Guides:
 1. Products shall be UL Listed in the latest publication of the UL Fire Protection Equipment Directory or approved in the latest Factory Mutual Research Corporation Approval Guide for service intended.

2.02 PIPE

- A. Below Ground:
 1. Pipe: Ductile iron, Class 52, American Water Works Association (AWWA) C151, minimum 350 psi working pressure, with standard cement mortar lining, AWWA C104, American National Standards Institute (ANSI) A21.4
 2. Fittings: Ductile iron or grey iron, mechanical joint, 350 psi working pressure, AWWA C153, cement mortar lined, AWWA C104
 3. Encasement: Polyethylene encasement, 8 mil thick, AWWA C105
- B. Above Ground:
 1. Carbon Steel, 2" and smaller:
 - a. Pipe: Carbon steel pipe, Schedule 40, American Society for Testing of Materials (ASTM) A795 or A53
 - b. Fittings:
 - 1) Malleable iron, threaded, Class 150, 300 psi Cold Water Pressure (CWP) rating, ASME B16.3
 - 2) Cast iron, threaded, Class 125, 175 psi CWP rating, ANSI B16.4
 - 3) Cast iron, flanged, Class 125, 175 psi CWP rating, ANSI B16.1
 - 4) Carbon steel butt weld, ASTM A234 Grade WPB/American Society of Mechanical Engineers (ASME) B16.9, standard weight, seamless
 - 5) Ductile iron or malleable iron, roll **[cut]** grooved for mechanical coupling, 175 psiCWP rating, malleable iron conforming to ASTM A47.
 - a) Acceptable manufacturers: Anvil Gruvlok, Tyco Grinnell, Victaulic, Viking, or equal
 - b) Fitting, gasket, and coupling shall be furnished by same manufacturer.
 - c. Joints:
 - 1) Threaded, tapered pipe threads, ANSI B1.20.1
 - 2) Flanged, cast iron, 175 psi CWP rating, ANSI B16.1, square head machine bolts with semi-finished hexagon nuts, ASTM A183, neoprene gasket
 - 3) Welded, welding electrodes shall be Lincoln or equal with coating and diameter as recommended by manufacturer for type and thickness of work being done.
 - 4) Mechanical:
 - a) Flexible mechanical, malleable iron, ASTM A47, equal to Victaulic Style 75
 - b) Rigid mechanical, ductile iron, ASTM A-536, equal to Victaulic Style 009N
 - c) Wet systems gasket: Grade E EPDM gasket per UL 157 and UL 213
 - d) Dry systems gasket: Victaulic "FlushSeal" or equal

- e) Rigid or zero flex type couplings shall be provided when operating pressures cause piping to move out of place or sway on hangers. Flexible couplings may be used where pipe is braced or clamped into rigid position.
2. Carbon Steel, larger than 2”:
- a. Pipe: Carbon steel pipe, Schedule 10, ASTM A795, A53, or A135
 - b. Fittings:
 - 1) Carbon steel butt weld, ASTM A234 Grade WPB/ASME B16.9, Schedule 10, seamless
 - 2) Ductile iron or malleable iron, roll grooved for mechanical coupling, 175 psi CWP rating, malleable iron conforming to ASTM A47.
 - a) Acceptable manufacturers: Anvil Gruvlok, Tyco Grinnell, Victaulic, Viking, or equal
 - b) Fitting, gasket, and coupling shall be furnished by same manufacturer.
 - c. Joints:
 - 1) Welded, welding electrodes shall be Lincoln or equal with coating and diameter as recommended by manufacturer for type and thickness of work being done.
 - 2) Mechanical:
 - a) Flexible mechanical, malleable iron, ASTM A47, equal to Victaulic Style 75
 - b) Rigid mechanical, ductile iron, ASTM A-536, equal to Victaulic Style 009N
 - c) Wet systems gasket: Grade E EPDM gasket per UL 157 and UL 213
 - d) Dry systems gasket: Victaulic “FlushSeal” or equal
 - e) Rigid or zero flex type couplings shall be provided when operating pressures cause piping to move out of place or sway on hangers. Flexible couplings may be used where pipe is braced or clamped into rigid position.
3. Flexible sprinkler hose fittings for fire protection service shall be manufactured by FlexHead Industries, Inc., 56 Lowland Street, Holliston, MA 01746; Telephone: (800) 829-6975. No substitutions allowed. Product shall be FMRC Approved for its intended use pursuant to FM 1637 – Approval Standard for Flexible Sprinkler Hose with Threaded End Fittings. Product shall be UL Listed for its intended use pursuant to UL 2443 – Standard for Flexible Sprinkler Hose with Fittings for Fire Protection Service. For seismic projects, product shall be seismically qualified for use pursuant to ICC–ES AC-156 – Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems. Provide high pressure fittings where pressures exceed 175 psi water working pressure. Model numbers on high pressure fittings must include the “H” suffix.
- a. FlexHead Flexible Hose Assemblies and End Fittings:
 - 1) Composition: 100% Type 304 Stainless Steel
 - 2) Shall be fully welded non-mechanical fittings, braided, leak-tested with minimum 1” true-bore internal corrugated hose diameter
 - 3) Straight Hose Assembly Lengths: 2 ft length, Model #2024; 3 ft length, Model #2036; 4 ft length, Model #2048; 5 ft length, Model #2060; 6 ft length, Model #2072
 - 4) Elbow Hose Assembly lengths: 2 ft length, Model 2024E; 3 ft length, Model #2036E; 4 ft length, Model #2048E; 5 ft length, Model #2060E; 6 ft length, Model #2072E
 - b. FlexHead Ceiling Bracket:
 - 1) Composition: Type G90 Galvanized Steel
 - 2) Type: Direct attachment type, having integrated snap-on clip ends positively attached to the ceiling using tamper-resistant screws
 - 3) Flexible hose attachment: Removable hub type with set screw
4. Provide metal pipe’s exposed threads with corrosion inhibitive paint, equal to Rust-Oleum.

5. Provide pipe identification system with flow directional arrows on fire protection pipe. For additional information about pipe identification, refer to Section 20 0553 – Mechanical Systems Identification.
6. Plain end couplings (Roust-A-Bouts, Plainloks or similar couplings) are not allowed on either new or existing sprinkler systems.
7. Adjustable drop nipples are not allowed on either new or existing sprinkler systems.
8. Shop welded joints:
 - a. Welding electrodes shall be Lincoln or equal with coating and diameter as recommended by manufacturer for type and thickness of work being done.

2.03 UNDERGROUND RESTRAINT

- A. Acceptable manufacturers: EBAA Iron, Inc., Smith-Blair, or equal
- B. Mechanical Joints Utilizing Setscrew Retainer Glands
 1. Mechanical joint restraint device for nominal pipe sizes 3" through 12" per AWWA C151, shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of AWWA C110/A21.10, body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536, minimum working pressure rating of 350 psi, includes torque limiting breakaway nuts, allows for a minimum of 3° of deflection, and includes fusion-bonded epoxy coating per AWWA C213.
 2. Mechanical restraint coupling gasket shall be furnished by same manufacturer.
- C. Pipe Clamps and Tie Rods
 1. Clamps, rods, and washers shall be sized per the requirements listed in NFPA 24.
 - a. Clamps shall be made of steel, used to prevent joint separation through use in combination with rod clamp washers, rod couplings, and heavy hex nuts.
 - b. Rods shall be carbon steel per ASTM A193 GR B7, using rolled threads for improved physical characteristics, greater thread accuracy, and smooth surface finish.

2.04 UNDERGROUND PENETRATION MODULAR SEAL

- A. Acceptable manufacturers: GPT Industries, Roxtec, or equal
- B. Modular sealing device consisting of sealing elements, pressure fittings, and hardware preassembled from manufacturer.
 1. Sealing elements: EPDM rubber that adjusts to the outside diameter of the pipe to ensure proper fitment and sealing.
 2. Pressure resistant to a minimum of 20 psig (40 ft. of head).
 3. Bolts and nuts: 316 stainless steel per ASTM F593
- C. Basis of Design: GPT Industries Link-Seal, Roxtec Model RS, or equal

2.05 VALVES

- A. Gate Valve:
 1. Acceptable manufacturers: Kennedy, Milwaukee Valve Co., Mueller, Nibco, Stockham, Victaulic, or equal
 2. Outside screw and yoke (OS&Y) gate valve, bronze body and trim or cast iron body bronze mounted and rated for 175 psi, non-shock water working pressure, Nibco F-607-OTS or equal.
 3. Provide high pressure valves and fittings when pressures exceed 175 psi water working pressure.
- B. Vertical Post Indicator Valve:
 1. Acceptable manufacturers: Kennedy, Mueller, Nibco, Stockham, Victaulic, or equal
 2. Non-rising stem (NRS) gate valve, ductile iron body, resilient wedge, epoxy coated interior and exterior, includes indicator post flange and flange screw, rated for 300 psi non-shock cold working pressure, Nibco F-609-RWS or equal.

3. Cast iron post with lockable lever operator for use with non-rising stem gate valve, 1" square valve stem extension rod, UV-stabilized Lexan window containing cast aluminum signage reading "OPEN" and "SHUT", Kennedy Model 2495A, Nibco NIP-1AJ, Victaulic Series 774, or equal.
- C. Check Valve:
1. Acceptable manufacturers: Globe Fire Sprinkler, Reliable, Tyco Fire Products, Victaulic, Viking, or equal
 2. Iron body, bronze seat, stainless steel clapper with a replaceable rubber seal, Globe Fire Sprinkler Model RCV, Tyco Fire Products CV-1F, Viking Model G-1, or equal.
 3. Provide high pressure valves and fittings when pressures exceed 300 psi water working pressure.
- D. Check Valve (Anti-Water-Hammer type)
1. Acceptable manufacturers: Anvil Gruvlok, Reliable, Tyco Fire Products, Victaulic, Viking, or equal
 2. Ductile iron conforming to ASTM A536, Grade 65-45-12, rust inhibiting coating, sizes 2" to 5" consisting of stainless steel clapper conforming to ASTM A-167 and for sizes 6" to 8" consisting of ductile iron clapper conforming to ASTM A-536, Anvil Gruvlok Series 7800 or equal.
 3. Provide high pressure valves and fittings where pressures exceed 175 psi water working pressure.
- E. Ball Valve:
1. Acceptable manufacturers: Milwaukee Valve Co., Mueller, Nibco, Stockham, Victaulic, or equal
 2. Bronze body and stem, full port design, brass ball with chrome plated finish, conforms to MSS SP-110 standard, Nibco Model KT-585-70-UL or equal.
 3. Provide high pressure valves and fittings when pressures exceed 300 psi water working pressure.
- F. Globe/Drain Valve:
1. Acceptable manufacturers: Milwaukee Valve Co., Mueller, Nibco, Stockham, Victaulic, or equal
 2. Bronze body, stem, bonnet, and packing nut; non-asbestos packing; nitrile seat disc; stainless steel handwheel screw or nut; Nibco Model KT-65-UL for valve sizes 1/2" to 1", Nibco Model KT-211-W-UL for valve sizes 1-1/4" to 2", or equal.
 3. Provide high pressure valves and fittings where pressures exceed 175 psi water working pressure.
- G. Butterfly Valve:
1. Acceptable manufacturers: Globe Fire Sprinkler, Kennedy, Milwaukee Valve Co., Mueller, Nibco, Stockham, Tyco Fire Products, Victaulic, or equal
 2. Globe Fire Sprinkler Model GL300 for valve sizes 1" to 2-1/2", or equal.
 3. Globe Fire Sprinkler Model GLR300 2-1/2" to 8", Kennedy Valve Co. Fig. G300 for sizes 2-1/2" to 6", Victaulic FireLock Series 705 for valve sizes 2-1/2" to 8", or equal.
 4. Provide high pressure valves and fittings when pressures exceed 300 psi water working pressure.
- H. Double Check Backflow Prevention Assembly (DCBP):
1. Acceptable manufacturers: Ames, Apollo, Cla-Val, Febco, Watts, or equal
 2. Weighted clapper double check valve assembly including 2 supervised outside screw and yoke (OS&Y) gate valves
 3. Assembly shall be double check valve assembly for cross connection devices.
 4. Certified in accordance with ASSE 1015 and AWWA C510

5. Double check valve shall be selected based on minimal pressure drop to allow maximum available pressure to sprinkler system.
6. Provide high pressure DCBP assembly and fittings when pressures exceed 175 psi.
- I. Test and Drain Valves:
 1. Acceptable manufacturers: AGF, Globe Fire Sprinkler, Victaulic, or equal
 2. AGF TESTanDRAIN, Globe Fire Sprinkler Model UTD, Victaulic Style 720 TestMaster II, or equal.
 3. Test and drain valve shall include integral pressure relief valve. Pressure relief valve shall be set to operate at 175 psi or 10 psi in excess of the maximum system pressure, whichever is greater.
 4. Provide high pressure valves and fittings where pressures exceed 175 psi water working pressure.
- J. Riser Manifold:
 1. Acceptable manufacturers: Globe Fire Sprinkler, Tyco Fire Products, Victaulic, Viking, or equal
 2. Ductile iron or fabricated steel pipe body; threaded or grooved connections; rated to 175 psi non-shock water working pressure; includes test and drain valve with integral pressure relief valve kit, flow switch without optional cover tamper kit, and pressure gauge; Globe Fire Sprinkler Model UM, Tyco Fire Products Model RM-1, or equal.
 3. Provide high pressure valves and fittings when pressures exceed 175 psi water working pressure.
- K. Universal Manifold Check Assembly:
 1. Acceptable manufacturers: Globe Fire Sprinkler or equal
 2. Ductile iron construction, incorporating a control valve, check valve, flow switch, test & drain assembly, adjustable pressure relief valve, and pressure gauges in one compact body/footprint, manufactured for right- and left-hand orientations, rated for use at the maximum service pressure of 300 psi, and UL Listed and FM Approved. The test & drain assemble shall contain an adjustable pressure relief valve, with a range of 175 psi to 310 psi, and a universal test orifice of K2.8. Globe Fire Sprinkler Model UMC or equal.
- L. Air Release Valve:
 1. Acceptable manufacturers: Engineered Corrosion Solutions, Potter Electric Signal Co., or equal
 2. Automatic float type air vent, ball valve with tamper switch, Y-type strainer, and single set of normally closed dry contacts rated 24VAC/DC at 2 Amps, UL 2573 Listed, FM Approved "Automatic Air Release Valve for Sprinkler Systems", rated to 175 psi non-shock water working pressure, Potter Electric Signal Co. Model PAAR-B or equal.
 3. Air release valve shall be installed in an accessible location to permit operation, maintenance, and visual inspection of the status of the valve.
 4. Provide high pressure valves and fittings when pressures exceed 175 psi water working pressure.
- M. Provide identification sign (enamel on metal) for valves per NFPA requirements. For additional information, refer to Section 20 0553 – Mechanical Systems Identification.
- N. Valves in galvanized piping shall be bronze.

2.06 TAMPER SWITCH

- A. Acceptable manufacturers: Potter Electric Signal Co., System Sensor, or equal
- B. Outside screw and yoke (OS&Y) supervisory switch, NEMA 4 enclosure, provided with 2 sets of SPDT (Form C) contacts rated at 2.5 Amps at 30 VDC and 15 Amps at 125/250 VAC. Provide without optional cover tamper kit. For areas identified as hazardous locations, provide "EX" Model. Potter Electric Signal Co. OSY series or equal.

- C. Control valve supervisory switch, NEMA 4 enclosure, provided with 2 sets of contacts rated at 2.5 Amps at 30 VDC and 15 Amps at 125/250 VAC. Provide without optional cover tamper kit. For areas identified as hazardous locations, provide "EX" Model. Potter Electric Signal Co. PIBV series or equal.
- D. Tamper switch shall be capable of transmitting signal during first 2 revolutions of handwheel or during 1/5 of travel distance of valve control apparatus from its normal position.
- E. Unit shall be compatible with building's fire alarm system.

2.07 FLOW SWITCH

- A. Acceptable manufacturers: Potter Electric Signal Co., System Sensor, or equal
- B. Vane type waterflow switch for use in wet sprinkler systems, minimum 300 psi service pressure rating, 10 gpm minimal flow rate to activate alarm, and 2 sets of SPDT (Form C) contacts. Provide without optional cover tamper kit. Potter Electric Signal Co. VS series or equal.
- C. Unit shall be compatible with building's fire alarm system.

2.08 SPRINKLERS

- A. Manufacturers:
 - 1. Unless otherwise noted below, shall be manufactured by Globe Fire Sprinkler, Reliable, Tyco Fire Products, Viking, or equal.
- B. Automatic, having temperature and pressure rating suitable for location.
- C. Light hazard occupancies shall utilize quick-response type sprinklers.
- D. Architect will review deviations from specified styles for approval prior to installation.
- E. Provide the following type of sprinklers
 - 1. Unfinished areas such as mechanical spaces:
 - a. Standard Coverage, Brass Upright or Pendent, ordinary temperature class (155°F), Globe Fire Sprinkler Model GL-QR, Tyco Fire Products Model TY-FRB, Viking Microfast, or equal.
 - b. Extended Coverage, Brass Upright or Pendent, large orifice, ordinary temperature class (155°F), Globe Fire Sprinkler Model GL-ECOH, Tyco Fire Products Model EC-11/14, Viking ECOH-ELO, or equal, designed and installed per its listing
 - 2. In areas with ceilings.
 - a. Standard Coverage, Concealed Pendent, ordinary temperature class (155°F), Globe Fire Sprinkler Model GL-QR/INCH, Tyco Fire Products Model RFII, Viking Mirage, or equal adjustable sprinkler with 139°F temperature class cover plate, mounted flush with ceiling. Cover plate color shall match ceiling color and shall be factory-painted (i.e. by manufacturer).
 - b. Standard Coverage, Semi-Recessed, ordinary temperature class (155°F), Globe Fire Sprinkler Model GL-QR, Tyco Fire Products TY-FRB, Viking Microfast, or equal. Sprinkler and escutcheon finish shall be standard bright white.
 - 3. In areas where ceiling conditions do not permit installation of pendent sprinkler or finished area where sidewall sprinkler provides better coverage of hazard.
 - a. Standard Coverage, standard bright white finish, ordinary temperature class (155°F), Globe Fire Sprinkler Model GL-QR/SW, Tyco Fire Products Model TY-FRB, Viking Microfast horizontal (HSW) or vertical (VSW) sidewall with Viking Microfast Model F-1 adjustable escutcheon, or equal.
 - b. Extended Coverage, standard bright white finish, ordinary temperature class (155°F), Globe Fire Sprinkler Model GL-QR/ECLH/SW, Tyco Fire Products Model TY-FRB or equal designed and installed per its listing
- F. Submit samples for examination and approval when appearance is different than sprinkler specified.

- G. Temperature class of sprinklers shall vary if installed close to heat sources, under skylights or in special hazard areas. Refer to NFPA 13 for requirements.
- H. Spare Sprinkler Cabinets:
 - 1. Shall be complete with required number of spare sprinklers of each type and temperature rating per NFPA 13.
 - 2. Shall be provided with at least one sprinkler wrench for each type of sprinkler installed.
 - 3. Provide multiple cabinets to meet this requirement.
 - 4. Coordinate cabinet locations with Owner's representative.

2.09 FIRE DEPARTMENT CONNECTION (FDC)

- A. Acceptable Manufacturers: Badger-Powhatan, Croker, Elkhart Brass, Guardian Fire Equipment, Potter-Roemer, Tyco Fire Products
- B. Flush Fire Department Connection: Potter-Roemer 5023-D-F, cast brass body, drop clappers, faceplate, two 2-1/2" snoots, pin-lug hose thread swivels, pin-lug plugs with chains, integral sillcock, polished chrome plated finish, AUTOSPKR lettering.

2.010 BALL DRIP

- A. Acceptable manufacturer: Potter-Roemer, Reliable, Tyco Fire Products, or equal
- B. Provide bronze ball drip for fire department connection (FDC) inside of building and pipe to nearest floor drain or discharge to exterior.
- C. Exterior discharge location must be coordinated with Architect and Owner.

2.011 HANGERS

- A. Acceptable manufacturers: Afcon, Anvil, Eaton, Pentair, Tolco, or equal
- B. Concrete expansion hangers, when provided, are to be Hilti, Illinois Tool Works (ITW), Powers Fasteners, or equal
- C. Hanger rods shall comply with Manufacturer Standardization Society (MSS) standards and manufacturer's published load rating.
- D. Provide hanger rod, hanger rod attachments, pipe stands, bolts, U-bolts, nuts, studs and washers with electroplated zinc coating or with hot-dipped galvanized finish.
- E. Riser clamps shall be electroplated zinc coated or have a hot-dipped galvanized finish and shall not protrude more than 2" beyond edge of hole, Anvil Fig. 261 or equal.

2.012 PRESSURE GAUGES

- A. Acceptable manufacturers: Ashcroft, Potter-Roemer, Viking, or equal
- B. Pressure gauges shall be 3-1/2", corrosion resistant moving parts, polycarbonate window, and provided with connection not smaller than 1/4" NPT.
- C. Include ball valve with provisions for draining on each pressure gauge.

2.013 DIELECTRIC FITTINGS

- A. Acceptable manufacturers: Epco Sales, Lochinvar, Watts Regulator Co., Wilkins, or equal
- B. Insulating nipple, metal casing, inert thermoplastic lining, Clearflow dielectric fitting by Perfection Corporation or equal.
- C. Dielectric unions 2" and smaller; dielectric flanges 2" and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets, and pressure rating of not less than 175 psig at 180°F. Provide high pressure type when pressures exceed 175 psi water working pressure.

PART 3 - EXECUTION

3.01 DESIGN CRITERIA

Flow Test: TBD

- A. Prior to preparation of installation drawings and hydraulic design calculations.

- B. Hydraulically calculated system shall be designed to a minimum of 10% below available water flow curve.
- C. Systems that are hydraulically calculated must include 1.2 factor for design area.
- D. Basis of Design:
 - 1. Office areas and general building spaces shall be hydraulically designed to provide minimum density of 0.10 gpm per sq ft over most hydraulically remote 1500 sq ft. Maximum spacing shall not exceed 225 sq ft per head.
 - 2. Laboratory areas, including corridors between labs separated from office areas by doors and firewalls, shall be hydraulically designed to provide minimum density of 0.15 gpm per sq ft over most hydraulically remote 1500 sq ft. Maximum spacing shall not exceed 130 sq ft per head.
 - 3. Mechanical equipment areas shall be hydraulically designed to provide minimum density of 0.15 gpm per sq ft for most remote 1500 sq ft. Maximum spacing shall not exceed 130 sq ft per head.
 - 4. General storage areas and chemical transfer area shall be hydraulically designed to provide minimum density of 0.15 gpm per sq ft over most hydraulically remote 1500 sq ft. Maximum spacing shall not exceed 130 sq ft per head.
- E. Hose Streams:
 - 1. Light Hazard Occupancy: 100 gpm inside/outside hose allowance
 - 2. Ordinary Hazard Occupancy: 250 gpm inside/outside hose allowance

3.02 INSPECTION

- A. Investigate site conditions; verify utility locations and elevations before start of excavation. Forward discrepancies to Architect/Engineer before proceeding with construction.

3.03 INSTALLATION

- A. Install hydraulically designed sprinkler system and associated accessories according to requirements of NFPA 13 and as shown on drawings.
- B. Install hydraulically designed standpipe system and associated accessories according to requirements of NFPA 14 and as shown on drawings.
- C. Install pipe, fittings, couplings, and valves according to requirements of manufacturer.
- D. Keep materials within listed temperature range to assure jointing in accordance with manufacturer's requirements.
- E. Pipe and fittings shall be of corresponding materials when assembled.
- F. Underground Pipe:
 - 1. Underground pipe shall be restrained against movement at changes in direction per the requirements of NFPA 24. Restraint shall be provided by using thrust blocks or one of the following methods:
 - a. Mechanical joint restraint utilizing setscrew retainer glands
 - 1) Mechanical joint restraint shall require conventional tools and installation procedures per AWWA C600, while retaining full mechanical joint deflection during assembly as well as allowing joint deflection after assembly.
 - 2) Proper actuation of the gripping wedges shall be ensured by use of torque limiting twist off nuts.
 - b. Pipe clamps and tie rods
 - c. Locking mechanical or push-on joints
 - d. Bolted flange joints
 - 2. Thrust blocks shall be of concrete, of a mix not leaner than one part cement, two and one-half parts sand, and fire parts stone.

3. Wherever possible, thrust blocks shall be located so that the joints are accessible for repair.
 4. Pipe clamps and tie rods shall not be installed where the pipe penetrates building walls or floors.
 5. Threaded sections of rods shall not be formed or bent.
 6. Except for fittings, valves, glands, and other accessories having an epoxy-coated finish, all rods, nuts, bolts, washers, clamps, and other restraining devices shall be cleaned and thoroughly coated with a bituminous or other acceptable corrosion-retarding material after installation.
 7. Provide metallic bond at each joint of ductile iron and cast iron pipe. Bond wire shall be type RHW-USE size 1/0 neoprene-jacketed copper conductor shaped to stand clear of joint.
 8. Polyethylene encasement shall be installed for ductile iron pipe. Refer to AWWA C105-10 for material standards and installation procedures.
- G. Above Ground Pipe:
1. Provide pipe identification system with flow directional arrows on fire protection pipe in accordance with manufacturer's installation instructions. For additional information, refer to Section 20 0553 – Mechanical Systems Identification.
 2. Coat exposed threads with corrosion inhibitive paint, equal to Rust-Oleum. Apply paint per manufacturer's instructions.
- H. Provide readily removable fittings at end of cross-mains. Minimum size of flushing connection shall be 2".
- I. Provide test connection for each flow switch.
- J. Discharge test connections inside building to receptacles provided as part of plumbing system or to standpipe's drain riser.
- K. Drain line detailed adjacent to standpipe/sprinkler risers shall be considered as part of Sprinkler System from combination test/auxiliary drain valve for each zone or sub-zone shown on plans to plumbing receptacle.
- L. Provide auxiliary drains at low points of systems per requirements of NFPA 13.
- M. Identify valve with brass tag denoting which flow switch is being tested, when test valves are located remote from flow switch.
- N. Clamp-on or saddle type fittings (i.e. mechanical tees) are not allowed. Outlet fittings inserted into holes drilled into piping or pipe-o-lets are not allowed.
- O. Provide reducing fittings or provide shop fabricated weld-o-lets to change pipe sizes in sprinkler/standpipe systems. No bushings or grooved reducing couplings, such as Victaulic Style 750, are allowed.
- P. Feed sprinklers, installed in finished ceilings, with FlexHead, swing joint, or return bend arrangement for final positioning in ceiling grid pattern during construction phases.
- Q. All arm-over and flexible sprinkler fittings shall be taken from the sides or top of the branch line. No arm-overs or flexible sprinkler fittings shall be connected to the bottom of the branch line.
- R. Sprinklers are required to be installed in the center of ceiling tiles.
- S. Install tamper switch on each shutoff valve.
- T. Install sprinklers as recommended by manufacturer. Sprinklers shall be set level and at locations to avoid interference with spray pattern of sprinkler. When ducts and lights are obstructions to sprinkler distribution, provide additional sprinklers beneath obstruction.
- U. Make joints of threaded pipe by cutting pipe square and reaming inside.
- V. Use joint compound sparingly.
- W. Install joints for mechanical coupled pipe according to manufacturer's recommendations. Use manufacturer's gasket lubricant sparingly.
- X. Pipe grooving shall be per coupling manufacturer's instructions.
- Y. Welded joints shall be made in fabrication shop. No welding allowed at project site.

- Z. Hangers, Bracing, and Restraint of System Piping:
1. Provide hangers and associated parts to support piping in perfect alignment without sagging or interference, to permit free expansion and contraction, and meet requirements of NFPA 13 and manufacturer's installation instructions.
 2. Select and size building attachments per Manufacturer Standardization Society (MSS) standards and manufacturer's published load rating.
 3. Coordinate hanger support installation to group piping of all trades.
 4. Hang pipe from building members using either concrete inserts for concrete construction or beam clamps for steel construction. Installation shall comply with manufacturer's installation instructions. Expansion type inserts may be used for branch piping.
 5. Restraining clips/clamps are required in locations where vibration may be a concern. Refer to Section 23 0550 – Vibration Isolation, for additional information regarding restraining clips/clamps.
 6. Suspend hangers by means of electroplated zinc or hot-dipped galvanized finish hanger rods. Perforated band iron and flat wire straps (strap iron) are not allowed.
 7. Mains parallel to joists shall not be supported from a single joist. Mains parallel to joists shall be supported by trapeze hanger and be positioned equally between two joists. Trapeze hangers shall be positioned to load joists at panel points only.
 8. Support pipe from top flange of beams.
 9. Where joists are used, locations of pipe supports shall be approved by the structural engineer prior to installation.
 10. Do not support equipment or piping from metal roof deck.
- AA. Install pressure gauges as required in manufacturer's installation instructions, and as required per NFPA standards.
- BB. Generally install capped tees in lieu of couplings for future connections.

3.04 CLEANING

- A. Flush sprinkler system to purge cutting oil, debris and metal fines.
- B. Ensure underground feed pipe has been flushed per NFPA 24 to clear out construction debris, prior to connecting aboveground fire protection system to it.
- C. Clean systems after installation is complete.
- D. Clean piping both internally and externally to remove dirt, plaster dust, or other foreign materials. When external surfaces of piping are rusted, clean and restore surface to original condition. Replacement of heavily soiled and deteriorated materials shall be done at the Contractor's expense.
- E. Clean equipment as recommended by manufacturers. Thoroughly clean equipment of stains, paint spots, dirt, dust, and any other foreign materials. Remove temporary labels not used for instruction or operation.

3.05 TESTING

- A. Refer to testing paragraph of Section 20 0000 – General Mechanical Requirements.
- B. Coordinate fire pump test with Division 26 and Division 28 contractors.
- C. Perform all NFPA required acceptance tests.
- D. Test sprinkler system as entire system or partial system. System shall be hydrostatically tested at not less than 200 psi or 50 psi above static pressure in excess of 150 psi for 2 h. No leakage allowed. Replace defective joints with new materials. No caulking of defective joints allowed. Re-test system after defective joints are replaced, until satisfactory results are obtained.
- E. Hydrostatically test piping between the exterior fire department connection (FDC) and the check valve in the fire department inlet pipe in the same manner as the balance of the system.
- F. Pipe shall not be concealed until satisfactorily pressure tested.
- G. Conduct drain test. Record static pressure and residual pressure per NFPA 13.

- H. Owner's representative or engineer may witness tests. Contractor shall notify Owner and Engineer a minimum of 3 days in advance to allow for participation.
- I. Log of tests shall be kept at job site and shall identify:
 - 1. Who performed test
 - 2. Time of test
 - 3. Date of test
 - 4. Section of system tested
 - 5. Results of test
 - 6. Completed Contractor's Material and Test Certification form(s) from NFPA 13
 - 7. Operate flow switches to test that signals are transmitted to Fire Alarm Control Panel.
- J. Include test for tamper switches.

END OF SECTION

**SECTION 221118
WATER DISTRIBUTION SYSTEM**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section covers interior domestic cold water, domestic hot water (120-140°F), domestic hot water return, nonpotable cold water and trap filler lines to a point 5 ft outside building wall.
- B. All components shall comply with NSF-61 and NSF-372 to be compliant with requirement for lead content of $\leq 0.25\%$ maximum weighted average.

1.02 RELATED WORK

- A. Section 20 0513 - Motors
- B. Section 20 0520 - Excavation and Backfill
- C. Section 20 0529 - Mechanical Supporting Devices
- D. Section 20 0553 - Mechanical Systems Identification
- E. Section 20 0700 - Mechanical Systems Insulation
- F. Section 22 2114 - Plumbing Specialties

1.03 QUALITY ASSURANCE

- A. Order pipe with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.
- B. Installed material not meeting specification requirements must be replaced with material that meets these Specifications without additional cost to Owner.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to ensure material is undamaged and complies with specifications.
- B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C. Offsite storage agreements will not relieve Contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

1.05 SUBMITTALS

- A. Manufacturer's technical data for the following:
 - 1. Pipe
 - 2. Fittings
 - 3. Joints
 - 4. Valves
 - 5. Unions and Flanges
 - 6. Dielectric fittings
 - 7. In-line centrifugal pumps
 - 8. Water hammer arrestors
- B. Shop Drawings on items specified herein.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials as specified shall be new unless otherwise noted.
- B. Materials shall be provided from list of approved manufacturers. Home Market, Generic Broker, or Wholesaler's house brands are not acceptable.

2.02 PIPE, FITTINGS, AND JOINTS

- A. Underground 2-1/2" and Smaller:

1. Copper:
 - a. Pipe: Copper tube, Type K, soft (annealed) temper in coils, ASTM B88
 - b. Fittings:
 - 1) Cast copper alloy, solder joint, pressure rated, ANSI B16.18
 - 2) Wrought copper, solder joint, pressure rated, ANSI b16.22
 - c. Joints: Lead free (<0.2%) solder, ASTM B32, flux, ASTM B813
 - d. Joints: Where joints are permitted, brazed, silver solder, BCuP-5 Type, AWS.A5.8, 1250°F melting point minimum.
 - e. Pre-insulated with polyurethane insulation and PVC jacket.
- B. Underground 3" and Larger:
 1. Ductile Iron:
 - a. Pipe: Ductile iron, Class 52, AWWA C151, with standard cement mortar lining, AWWA C104
 - b. Fittings:
 - 1) Ductile iron or grey iron, mechanical joint, cement mortar lined, Class 250, AWWA C110
 - 2) Ductile iron, mechanical joint compact fittings, Class 350, AWWA C153
 - c. Joints: Joint shall be restrained type equal to EBAA Iron Megalug 15MJ00TD restraint system for mechanical joint for ductile iron pipe, AWWA C151/A21.51 and AWWA C150/A21.50. Joints shall be designed to accommodate deflection after assembly up to 3°.
 - d. Encasement: provide 8 mil tube or sheet polyethylene encasement of iron pipe and pipe fittings, AWWA C105
 2. Polyvinyl Chloride (PVC):
 - a. Pipe:
 - 1) PVC pressure pipe, DR 18, Class 150, AWWA C900; integral bell and elastomeric gaskets, ASTM D3139
 - 2) PVC pressure pipe, Schedule 80, ASTM D1785, AWWA C900
 - b. Fittings:
 - 1) Ductile iron or grey iron, mechanical joint, cement mortar lining, AWWA C104
 - 2) Ductile iron, mechanical joint compact fittings, Class 350, AWWA C153
 - 3) PVC, Schedule 80, socket pattern
 - c. Joints:
 - 1) Elastomeric gaskets, ASTM C3139
 - 2) Primer, ASTM F656; solvent cement, ASTM D2564
- C. Above Ground:
 1. Copper (2-1/2" and Smaller):
 - a. Pipe: Copper tube, Type Lhard drawn, ASTM B88
 - b. Fittings:
 - 1) Cast copper alloy, solder joint, pressure rated, ANSI B16.18
 - 2) Wrought copper, solder joint, pressure rated, ANSI B16.22
 - 3) Copper, press fit joint, EPDM O-ring, ANSI B16.51, 0° - 250°F, maximum 200 psig. Propress by Viega, ApolloPress by Apollo Flow Controls or Presssystem by Nibco.
 - c. Joints:
 - 1) Lead free (<0.2%) solder, ASTM B32, flux, ASTM B813
 - 2) Press fit joint, EPDM O-ring, made with electro-hydraulic crimping tool and jaw correct for pipe size.
 - d. Nipples: Red brass pipe, threaded

- e. Exposed tubing and fittings in kitchen and areas subject to chemical cleaning shall have chrome plated finish.

2.03 UNIONS AND FLANGES

- A. General:
 - 1. Unions, flanges and gasket materials to have pressure rating of not less than 150 psig at 180°F.
- B. Copper (3" and Smaller):
 - 1. Wrought copper union, Nibco Figure 633-W. Mueller Brass equal.
- C. Copper (4" and Larger):
 - 1. Cast red brass flanges, alloy 844, ASTM B584, Class 150, Standard bolt pattern, ANSI B16.24 with neoprene gasket
- D. Copper (3" and Larger):
 - 1. Ductile iron flange adapters, ASTM A 536, coated with copper-colored enamel for use with grooved end pipe and fittings, flat face, manufactured for engaging directly into roll grooved copper tube and fittings and bolting directly to flanged components with ANSI Class 125 and 150 bolt hole patterns, EPDM gasket. Victaulic Style 641.

2.04 VALVES

- A. Shutoff Valves:
 - 1. Ball Valves (2-1/2" and smaller):
 - a. Acceptable manufacturers: Apollo, Hammond, Milwaukee, Nibco, Stockham and Watts with indicated features and equal to model listed. Note that not all manufacturers make all sizes. Basis of design valves have threaded or soldered ends. Equivalent valves with press ends are acceptable when press fit joints and fittings are allowed.
 - b. Full Port, 2 Piece: Bronze body, ASTM B584, stainless steel ball and stem, teflon seats, stem extension with length according to installed system insulation thickness, 600 psi CWP pressure rating, Apollo Series 77CLF-240-01 or approved equal.
 - c. Full Port, 3 Piece: Bronze body, ASTM B584, stainless steel ball and stem, teflon seats, stem extension with length according to installed system insulation thickness, 600 psi CWP pressure rating, Apollo Series 82LF-240 or approved equal.
 - d. Insulated Handle: For insulated systems to prevent condensation on valve body with thermal and vapor seal, equal to Apollo Therma Seal.
 - 2. Butterfly Valves (3" and larger):
 - a. Acceptable Manufacturers: Apollo, Hammond, Kitz, Milwaukee, Nibco, and Stockham with indicated features and equal to model listed. Note that not all manufacturers make all sizes or styles.
 - b. Grooved Type:
 - 1) Cast brass body, aluminum-bronze disc, stainless steel stem. Disc shall be offset from stem centerline to provide full 360 degree seating. Elastomeric seal, copper tubing sized grooved ends, 300 psi CWP pressure rating, manual level or gear operator with handwheel for 3" to 6", Victaulic Series 608N.
 - 2) Ductile iron body, electroless nickel-plated ductile iron disc, blowout proof 416 stainless steel stem. Disc shall be offset from stem centerline to provide full 360 degree seating. Seat and seal material shall be pressure responsive EPDM, TFE lined fiberglass bearings, grooved ends, 300 psi CWP pressure rating, manual lever lock handle or gear operator with handwheel, 3" to 12", Victaulic Vic 300 Masterseal.
 - 3) Stainless steel body and disc, ASTM A351 Grade CF8M, stainless steel stem. Disc shall be offset from stem centerline to provide full 360 degree seating. Seat

and seal material shall be EPDM, grooved ends, 300 psi CWP pressure rating, manual lever lock handle or gear operator with handwheel, 3" to 8", Victaulic Series 861.

3. Gate Valves:
 - a. Acceptable Manufacturers: Apollo, Crane, Hammond, Kennedy, Milwaukee, Nibco, and Stockham with indicated features and equal to model listed. Note that not all manufacturers make all sizes.
 - b. Size 2-1/2" and Larger: Nickel iron body and wedge, stainless steel trim, outside screw and yoke (OS&Y), 125 psi steam pressure rating, bolted bonnet, flanged pipe ends, Hammond IR1913-HI or approved equal.
- B. Swing Check Valves:
 1. Size 2" and Smaller:
 - a. Bronze body, ASTM B62, Y pattern, Buna-N resilient disc, horizontal swing, 200 psi CWP rating, Apollo 163S-LF series or approved equal.
 2. Valves 2-1/2" and Larger:
 - a. Nickel iron body, horizontal swing, stainless steel or nickel iron disc, stainless steel replaceable seat, 200 psi CWP rating, Nibco F-918-13 or approved equal.
- C. Spring Check Valves:
 1. Valves 2" and Smaller:
 - a. Bronze body, ASTM B584, in-line lift type with spring, Buna-N or PTFE disc, 250 psi CWP rating, Nibco 480-Y-LFApollo 61LF-500 series or approved equal.
 2. Valves 2-1/2" and Larger:
 - a. Cast iron body, wafer type, Buna-N seat, aluminum bronze disc, in-line type with stainless steel spring, 250 psi CWP rating, Mueller 103MAT or approved equal.
- D. Balancing Valves:
 1. Circuit Setter:
 - a. Acceptable Manufacturers: Bell and Gossett, Watts or approved equal
 - 2" and Smaller: Shall be of lead-free bronze construction with glass and carbon-filled TFE seat rings and have differential pressure read-out ports across valve seat area. Read-out ports to be filled with internal EPT insert and better connection with check valve. Valve bodies to have 1/4" NPT tapped drain/purge port. Valves to have memory stop feature and calibrated nameplate to assure specific valve setting. Valve to be leak-tight at full-rated working pressure and temperature (300 psi/250°F). B&G Circuit Setter Model CBo or approved equal.
 2. Thermostatic Balancing Valve
 - a. Acceptable Manufacturers: ThermOmegaTech or approved equal
 - b. Stainless steel body, piston and spring, NSF 61 certified, set to fully open at 110F and close at 120F.

2.05 DIELECTRIC FITTINGS

- A. Dielectric unions 2" and smaller; dielectric flanges 2-1/2" and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets and pressure rating of not less than 175 psig at 180°F. Watts Regulator Company, Lochinvar, Wilkins or Epco Sales, Inc.
- B. Copper-silicon casting, UNS C87850, threaded or grooved end. UL classified in accordance with NSF-61 for potable water service. Victaulic Style 647

2.06 WATER HAMMER ARRESTORS

- A. Mechanical Water Hammer Arrestors:
 1. Piston-compressed air column type, with sealed air chamber.

2. Manufacturers: Watts, Sioux-Chief, and Precision Plumbing Products (PPP), Inc., equal to size shown. Provide access panels when mechanical shockstops are installed in non-accessible concealed locations.

2.07 IN-LINE CENTRIFUGAL PUMPS FOR TEMPERATURE MAINTENANCE OF POTABLEHOT WATER

- A. Manufacturers: Armstrong, Aurora, Bell and Gossett, Deming, Ingersoll-Rand, Taco, Weinman, or Worthington
- B. Pumps shall be pipeline mounted, single suction type with cast iron casing, bronze fitted with working pressure of 125 psi and operating temperature of 200°F continuous.
- C. Impellers shall be plastic and shall be directly hung from motor shafts without using flexible couplings.
- D. Pump shafts shall be ceramic, steel or stainless steel, sealed and gasketed from pumped fluid.
- E. Pumps shall be furnished with mechanical carbon/silicon carbide seals.
- F. Bearing assemblies and motor shall be permanently oil lubricated and maintenance free.
- G. Pump shall be controlled by aquastat located in return pipe at pump with 100°F to 240°F operating temperature with 5°F to 30°F adjustable differential, remote bulb, UL listed similar to Honeywell L6006A1012.
- H. Refer to Section 26 2913 - Enclosed Controllers.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.
- B. Maintain piping system in clean condition during installation. Remove dirt and debris from assembly of piping as work progresses. Cap open pipe ends where left unattended or subject to contamination.
- C. Include connections to plumbing fixtures, to equipment by others, and to equipment requiring water. Provide proper backflow and back siphonage protection to safeguard potable water system from contamination.
- D. Lay out water system so as to conform to intent of drawings. Coordinate piping with building features and work of other trades. Install water piping plumb and square with building. Plans indicate, general routing, provide additional offsets as required. Install piping with necessary swing joints and offsets to allow for expansion.
- E. Install shut-off valves on branch lines near mains to avoid long dead-leg branches when valves are closed.
- F. Install shut-off valves where indicated and at base of risers to allow isolation of portions of system for repair.
- G. Do not install water piping within exterior walls.
- H. Provide drain valves at base of risers and at low points of trapped piping 2" and larger where trapped water volume exceeds 5 gallons.
- I. Install pressure reducing valves where indicated on drawings. Provide pressure gauges on both inlet and outlet sides of valve. Flush strainer and adjust to outlet pressure as scheduled.
- J. Provide protective sleeve covering of elastomeric pipe insulation where copper or steel piping is embedded in masonry or concrete.
- K. Provide dielectric fittings between dissimilar piping materials.
- L. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.
- M. Install valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make connections to

equipment, fixtures and systems installed by others where same requires piping services indicated in this Section.

- N. In-line pumps 3 hp and larger shall be independently supported from building structure.
- O. Install water pipe using proper pipe and fittings. Use reducing fittings for changes in pipe size.
- P. Install trap filler lines to slope to drain tailpiece without trapping.

3.02 UNDERGROUND WARNING TAPE

- A. Provide warning tape for exterior buried utilities per Section 20 0553.

3.03 COPPER TUBING

- A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.
- B. Soldered Copper Joints:
 - 1. Use non-acidic and lead free flux on cleaned pipe and fittings for soldered joints.
 - 2. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
 - 3. Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.
 - 4. Apply heat carefully to prevent damage to pipe, fittings and valves.
 - 5. Follow manufacturer's recommendations when heating valves and equipment for soldered connections.
- C. Brazed Copper Joints:
 - 1. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
 - 2. Joints shall be cleaned and polished before brazing.
 - 3. Flux of any type shall not be used.
 - 4. Apply heat carefully to prevent damage to pipe, fittings and valves. Disassemble valves where possible to prevent damage to seats during brazing.
- D. Press Fit Copper Joint:
 - 1. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
 - 2. Tubing shall be clean and dry before inserting into fittings.
 - 3. Insert pipe fully into fitting and mark on pipe at shoulder of fitting.
 - 4. Check fitting alignment against mark on pipe to ensure pipe is fully engaged.
 - 5. Crimp joint with pressing tool approved by fitting manufacturer.
- E. Grooved Copper Joints:
 - 1. All grooved end piping products shall be supplied by single manufacturer. Grooving tools shall be supplied by same manufacturer as grooved fittings and components.
 - 2. Install rolled groove copper pipe and fittings using equipment specifically for copper tube by mechanical coupling manufacturer.
 - 3. Use only those couplings and gaskets so designated for copper tube.
 - a. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
 - b. Gaskets shall be supplied by the grooved coupling manufacturer.
 - 4. Flaring of tube and fitting ends to IPS dimensions is not permitted.
 - 5. Grooved end shall be clean and free from indentations, projections, and roll marks in area from pipe end to groove for proper gasket sealing.
 - 6. Factory-trained field representative shall provide on-site training for contractor's field personnel in proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically review product installation. Contractor shall remove and replace any improperly installed products.

3.04 SPRING LOADED CHECK VALVES

- A. Provide spring loaded check valve in each pump discharge line.

3.05 WATER HAMMER ARRESTORS

- A. Use water hammer arrestors to control water hammer. Installed devices shall be sized and located according to manufacturer's recommendations, PDI Standards, or as shown on drawings.
- B. Use water hammer arrestors with flush valves and quick-closing valves. Provide access panels when water hammer arrestors are installed in non-accessible concealed locations.

3.06 DIELECTRIC UNIONS AND FLANGES

- A. Install dielectric unions or flanges at points where copper-to-steel pipe connection is required in domestic water systems.
- B. Install unions on equipment side of shutoff valves for items such as: water heaters, water softeners, pumps, filters, and similar equipment requiring periodic replacement.

3.07 CLEANING

- A. Flush and clean piping prior to testing. Remove corrosion by mechanical or chemical means. Use chemicals that are non-toxic.

3.08 TESTING

- A. Refer to Testing paragraph of Section 20 0000 - General Mechanical Requirements.
- B. Water test system may be applied to system in its entirety or in sections. Test piping with water to pressure of 160 psi for 2 h. No decrease in pressure allowed. Provide pressure gauge with shutoff and bleeder valve at highest point of system tested. Inspect joints in system under test.
- C. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.
- D. Do not conceal pipe until satisfactorily tested.
- E. Testing with air will not be allowed.

3.09 BALANCING

- A. Balance water distribution system. Adjust control valves for proper operation. Set balancing valves to maintain hot water in hot water system.
- B. Balance flush valves, flow control valves and mixing valves for adequate flow and temperature to plumbing fixtures and equipment.

3.010 DISINFECTION

- A. Disinfect water piping in the following manner:
 - 1. Clean and flush water pipe with water until water at remote tap is clear.
 - 2. Fill water systems with solution containing 50 ppm of chlorine (minimum concentration). Allow solution to stay in water system for 24 h. Alternately use solution of 200 ppm of chlorine (minimum concentration) for 3 h.
 - 3. Flush water system of chlorine solution.
 - 4. Allow clean water to stand in system for 24 h. Take sample from remote tap for bacteriological test.
- B. Do not use water system for potable water supply until safe bacteriological test is obtained. Repeat steps 1 through 4 until safe water system is obtained.

3.011 BACTERIOLOGICAL TESTS

- A. Take representative water samples and test to ensure bacteriologically safe water supply system. Include HPC (Heterotrophic Plate Count) test and test for presence of *Pseudomonas aeruginosa* as well as regular coliform bacteria test. HPC test maximum containment level of 500 organisms/ml. Perform bacteriological tests shortly before Owner's acceptance of building. If tests fail, make corrections and retest.
- B. When connecting to existing water supply of unknown quality, sample for analysis and comparison with finished water system analysis shall be taken prior to making new connection. This will allow isolating source of contamination from within scope of work or pre-existing water supply. Final conditions shall meet criteria specified above for areas within scope of work.

END OF SECTION

**SECTION 221314
SANITARY WASTE AND STORM DRAINAGE SYSTEMS**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section includes materials and methods for sanitary waste and vent, clearwater waste and vent, storm drainage, and overflow storm drainage piping systems within and including piping to 5 ft outside building wall.

1.02 RELATED WORK

- A. Section 20 0513 - Motors
- B. Section 20 0520 - Excavation and Backfill
- C. Section 20 0529 - Piping and Equipment Supporting Devices
- D. Section 20 0700 - Mechanical Systems Insulation
- E. Section 22 2114 - Plumbing Specialties
- F. Section 22 4000 - Plumbing Fixtures

1.03 QUALITY ASSURANCE

- A. Order piping with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.
- B. Installed material not meeting specification requirements must be replaced with material that meets these specifications without additional cost to Owner.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to insure material is undamaged and complies with Specifications.
- B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings by storage inside or by durable, waterproof, above ground packaging.
- C. Offsite storage agreements will not relieve Contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

1.05 SUBMITTALS

- A. Manufacturer's technical data for the following:
 - 1. Pipe and fittings
 - 2. Joints
 - 3. Cleanouts
 - 4. Floor drains and floor sinks
 - 5. Roof drains
 - 6. Downspout nozzles
 - 7. Air gap fittings
 - 8. Discharge check valves
 - 9. Discharge isolation valves
 - 10. Traps
 - 11. Sump pumps

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials herein specified shall be new, unless otherwise noted.

2.02 PIPE, FITTINGS, AND JOINTS

- A. Interior Underground 15" and Smaller:
 - 1. Cast Iron:

- a. Pipe: Hub and spigot pipe, service weight, ASTM A74, NSF certified or CISPI marked.
 - b. Fittings: Hub and spigot fittings, service weight, ASTM A74, NSF certified or CISPI marked. Joints: [Neoprene rubber compression gaskets, ASTM C564
2. Polyvinyl Chloride (PVC):
- a. Pipe:
 - 1) Schedule 40, CLASS 12454 (PVC 1120), ASTM D1785
 - b. Fittings: Socket fitting, DWV patterns, ASTM D3311. Fabricated fittings 10" and larger shall be per ASTM F1866.
 - c. Joints: Primer, low VOC, ASTM F656; solvent cement, low VOC, ASTM D2564
- B. Pressurized Underground 3" and Smaller:
1. Polyvinyl Chloride (PVC):
 - a. Pipe: Schedule 40, Class 12454 (PVC 1120), ASTM D1785
 - b. Fittings: Socket pattern pressure fittings, ASTM D2466
 - c. Joints: Primer, low VOC, ASTM F656; solvent cement, low VOC, ASTM D2564
- C. Pressurized Underground 3" and Larger:
1. Polyvinyl Chloride (PVC):
 - a. Pipe: DR 18, Class 150, AWWA C900, with integral bell
 - b. Fittings:
 - 1) Ductile iron or grey iron mechanical joint cement mortar lined fittings, class 250, awwa c110
 - 2) Ductile iron mechanical joint compact fittings, class 350, awwa c153
 - c. Joints: Elastomeric gaskets, ASTM C3139
- D. Interior Above Ground:
1. Cast Iron:
 - a. Pipe: Hubless cast iron pipe, ASTM A-888, CISPI 301, NSF certified or CISPI approved.
 - b. Fittings: Hubless cast iron fittings, ASTM A-888, CISPI 301, NSF certified or CISPI approved.
 2. Polyvinyl Chloride (PVC):
 - a. Pipe: Schedule 40, Class 12454 (PVC 1120), ASTM D1785
 - b. Fittings: Drain, waste and vent (DWV) pattern fittings, ASTM D2665; socket fitting patterns, ASTM D3311. Fabricated fittings 10" and larger shall be per ASTM F1866.
 - c. Joints: Primer, low VOC, ASTM F656; solvent cement, low VOC, ASTM D2564
- E. Pressurized Interior Above Ground:
1. PVC (3" and smaller):
 - a. Pipe: Schedule 40, Class 12454 (PVC 1120), ASTM D1785
 - b. Fittings: Socket pattern pressure fittings, ASTM D2466
 - c. Joints: Primer, low VOC, ASTM F656; solvent cement, low VOC, ASTM D2564
- F. Adapter Couplings for Joining Dissimilar Pipe Materials:
1. Acceptable Manufacturers: Fernco, Mission
 2. 1" through 6" diameter: Fernco Proflex 3000 Series shielded coupling with neoprene gasket, stainless steel shield, and stainless steel clamping bands. Adapter couplings shall be specifically designed for pipe materials being joined.

2.03 VALVES

- A. Pump Discharge Check Valves:
1. Acceptable Manufacturers: Hammond, Milwaukee, Nibco and Stockham with indicated features and equal to model listed
 2. Size 2" to 4", Horizontal Installation:

- a. Cast iron body, swing check, bronze disc and ring, brass pin, Class 125, threaded ends, Nibco T-918-B
3. Size 2-1/2" and Larger, Vertical Installation:
 - a. Cast iron body, swing check, bronze disc to 4" and cast iron disc with bronze disc face rings or bronze disc for 5" and up, lever and spring operator, brass pin, Class 125, flanged ends, Nibco F-918-BLS
4. Size 4" and smaller:
 - a. Acceptable manufacturers: Chemtrol, Iplex, Spears, or approved equal
 - b. PVC body, swing check, EPDM seals, flanged ends. Spears 4423-(size)
- B. Pump Discharge Isolation Valves:
 1. Ball Valves:
 - a. Acceptable Manufacturers: Apollo, Hammond and Nibco with indicated features and equal to model listed
 - b. Size 2" to 3":
 - 1) Full Port, 2 Piece: Bronze body, ASTM B584, stainless steel ball, teflon seats, stem extension, 600 psi CWP pressure rating, Apollo Series 77-240 or approved equal.
 2. Size 2" and smaller:
 - a. Acceptable manufacturers: Chemtrol, Iplex, Spears, or approved equal
 - b. True union, full port ball valve, CPVC body, ASTM D1784, EPDM o-rings, Teflon seats, socket ends. Iplex VX series

2.04 CLEANOUTS

- A. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to number listed in Drains and Cleanout Schedule.
- B. Provide recessed, solid brass, cleanout plugs where fittings are used as cleanouts. Provide taper-thread plug with Teflon tape thread wrap.
- C. Floor Cleanouts: Cleanout with cast iron ferrule, adjustable top, nickel-bronze scoriated cover and frame, bronze taper-thread plug, equal to J.R. Smith 4033L. Provide flashing flange and clamp where cleanout is installed in elevated slabs, equal to J.R. Smith 4033L-F-C.
- D. Floor Cleanouts, Carpeted Areas: Cleanout with cast iron ferrule, adjustable round top, nickel-bronze scoriated cover and frame, bronze taper-thread plug, and small stainless steel carpet marker, equal to J.R. Smith 4033L-Y. Provide flashing flange and clamp where cleanout is installed in elevated slabs, equal to J.R. Smith 4033L-F-C-Y.
- E. Floor Cleanouts, Tiled Areas: Cleanout with cast iron ferrule, adjustable square tile top, nickel-bronze scoriated cover and frame, and bronze taper-thread plug, equal to J.R. Smith 4053L. Provide flashing flange and clamp where cleanout is installed in elevated slabs, equal to J.R. Smith 4053L-F-C.
- F. Floor Cleanouts, Unfinished Floors and Areas Outside Building: Cleanout with cast iron ferrule, adjustable round top, scoriated cast iron tractor cover, and bronze taper-thread plug, equal to J.R. Smith 4239L. Provide flashing flange and clamp where cleanout is installed in elevated slabs, equal to J.R. Smith 4239L-F-C.
- G. Floor Cleanouts, Areas with Heavy Traffic: Cleanout with cast iron ferrule, adjustable housing, heavy-duty ductile iron scoriated top, and brass taper-thread plug, equal to J.R. Smith 4233L-M. Provide flashing flange and clamp where cleanout is installed in elevated slabs, equal to J.R. Smith 4233L-M-F-C.
- H. Wall Cleanouts: Cleanout with cast iron counter sunk ferrule, bronze or brass taper-thread plug, secured stainless steel access cover, equal to J.R. Smith 4472T.

2.05 FLOOR DRAINS

- A. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to number listed herein or in Drains and Cleanout Schedule.
- B. Floor drains shall be in accordance with ANSI A112.21.1. Provide with caulked or no-hub connection. Floor drains shall have internal seepage collar for embedding in floor construction and weep holes to provide adequate drainage to drain pipe. Include trap primer connection where indicated on drawings.

2.06 ROOF DRAINS AND OVERFLOW DRAINS

- A. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to number listed in Cleanouts and Drain Schedule
- B. Roof drains and overflow drains shall have cast iron body with adjustable collar, cast iron flashing ring, gravel stops, 10" diameter cast iron dome strainer, and cast iron underdeck clamp. J.R. Smith 1010Y-RC-CID.
- C. Expansion joints shall be cast iron joint with bronze pipe sleeve and neoprene gasket. J.R. Smith 1710.

2.07 AIR GAP FITTINGS

- A. Air gap fittings constructed of cast iron with integral air gap having free area of at least twice the inlet area. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to J.R. Smith 3950 or 3951.

2.08 DOWNSPOUT NOZZLES

- A. Acceptable Manufacturers: Josam, Smith, Wade or Zurn equal to number listed
- B. Downspout nozzles shall be polished bronze body, wall flange and threaded inlet, equal to J.R. Smith #1770-PB.

2.09 TRAPS

- A. Same material as pipe or fittings unless specified with fixtures. Refer to Section 22 4000 - Plumbing Fixtures. Provide 17 ga brass, chrome plated traps for exposed traps.

2.010 ELEVATOR SUMP PUMPS

- A. Acceptable manufacturers: Aurora/Hydromatic; Liberty, Stancor, Inc., Weil
- B. Pump shall be submersible type constructed of epoxy coated cast iron shell, cast iron volute, two vane enclosed recessed vortex non-clog bronze impeller, stainless steel shaft, stainless steel fasteners, upper sleeve and lower ball bearing factory sealed grease lubricated, and ceramic mechanical seal.
- C. Pump shall be hermetically sealed, capacitor start, built-in thermal overload protection sized for no-overloading entire pump curve.
- D. Pump shall be of capacity and electrical service as indicated in the equipment schedules on the drawings.
- E. Pump controls shall include:
 - 1. Single on/off UL listed float switch
 - 2. Oil sensor to terminate operation on oil
 - 3. Alarm with dry contact to BAS
- F. Pump accessories shall include:
 - 1. Discharge check valve
 - 2. Full port ball valve
 - 3. Union for each pump

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

- A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.
- B. Connect piping to fixtures, each piece of equipment, and drains. Install required piping as shown on drawings.

- C. Grade horizontal lines with minimum of 1/8" per ft, except piping 2" diameter or smaller which shall be run at 1/4" per ft slope.
- D. Grade horizontal lines with minimum of 1/4" per ft, except piping 4" diameter or larger which may be run at 1/8" per ft slope with approval of local authority.
- E. Install piping parallel with building lines and at heights, which do not obstruct any portion of window, doorway, stairway, or passageway, except, as may be shown on plans. Install overhead piping as high as possible.
- F. Grade vent pipe for complete drainage by gravity to soil or waste pipes. Vent terminations shall be set true and level. Locate vent piping at least 10 ft away from window, door or intake openings. Coordinate closely with roofing contractor to prevent damage to roofing membrane. Flashing shall be in accordance with requirements of roofing manufacturer.
- G. Where interferences develop, offset or reroute piping as required to clear interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. Consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- H. Provide protective sleeve covering of elastomeric pipe insulation, where piping and/or fittings are embedded in masonry or concrete.
- I. Maintain piping in clean condition internally during construction.
- J. Mitered ells, notched tees, and orange peel reducers are not allowed. Bushings are not allowed on threaded piping.
- K. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.
- L. Set cleanouts true and level and protect properly throughout construction.
- M. Set floor drains true and level and protect properly throughout construction. Weep holes shall be filled with removable material and kept free from concrete and other debris during construction. Weep holes shall be cleaned out for final working order. Provide safing for floor drains installed in elevated slabs.
- N. Trap each fixture and piece of equipment requiring sanitary drainage connections. Trap seals shall be standard depth, except when deep seals are required by code. Traps shall be set true and level and located within limits of code requirements. Traps shall not be used as separator, interceptor or other type of device to retain solids. Traps shall be provided with thread type approved cleanout plugs when specified. Protect traps during construction and seal off to prevent stones, debris and other foreign matter from entering before use. Locate running traps for full accessibility with double cleanout.
- O. Provide plugs or caps for pipe openings during construction to prevent debris from entering pipe. Temporary plug shall be plastic cap or equivalent.

3.02 UNDERGROUND WARNING TAPE

- A. Provide warning tape for exterior buried sewers per Section 20 0553.

3.03 POLYVINYL CHLORIDE (PVC) PIPE

- A. Pipe Joints:
 - 1. Install in accordance with ASTM D2855 "Making Solvent Cemented Joints with PVC pipe and Fittings". Saw cut piping square and smooth. Tube cutters may be used if fitted with wheels designed for use with PVC pipe that do not leave raised bead on pipe exterior. Support and restrain pipe during cutting to prevent nicks and scratches. Bevel ends 10-15 degrees and deburr interior. Check dry fit of pipe and fittings. Reject materials, which are out of round or do not fit within close tolerance. Use heavy body solvent cement for large diameter fittings.

2. Maintain pipe, fittings, primer and cement between 40°F and 100°F during application and curing. Apply primer and solvent using separate daubers (3" and smaller piping only) or clean natural bristle brushes about 1/2 size of pipe diameter. Apply primer to fitting socket and pipe surface with scrubbing motion. Check for penetration and reapply as needed to dissolve surface to depth of 4-5 thousandths. Apply solvent cement to fitting socket and pipe in amount greater than needed to fill gap. While both surfaces are wet, insert pipe into socket fitting with quarter turn to bottom of socket. Solvent cement application and insertion must be completed in less than 1 minute. Minimum of 2 installers is required on piping 4" and larger. Hold joint for 30 seconds or until set, whichever is longer. Reference manufacturer's recommendations for initial set time before handling and for full curing time before pressure testing.
- B. Install plastic pipe and fittings as recommended by manufacturer. Include adequate offsets or expansion joints to allow for pipe expansion.
- C. Do not install plastic pipe in plenum space.

3.04 CAST IRON PIPE

- A. No-hub Piping: Place gasket on end of one pipe or fitting and clamp assembly on end of other pipe or fitting. Firmly seat pipe or fittings ends against integrally molded shoulder inside neoprene gasket. Slide clamp assembly into position over gasket. Tighten fasteners to manufacturer's recommended torque.
- B. Hub and Spigot Piping: Clean pipe end, bell, gasket seat and gasket of dirt or debris. Coat end of pipe and gasket with gasket lubricant. Insure pipe is supported off ground so lubricant does not pick up dirt. Push spigot end into end of gasket bell with levered pipe joining tool recommended by pipe manufacturer. Large diameter exterior mains may be joined by pushing end of pipe section with backhoe against wood blocking over pipe end. Insert to fully seated position or to reference mark on pipe.
- C. Install cast iron pipe and fittings as recommended by CISPI in their publication "Installation of Cast Iron Soil Pipe and Fittings".
- D. Support piping at every coupling. Locate hanger within 18" of coupling.
- E. Installations with multiple joints within a 4 ft developed length shall be supported at every second joint.
- F. Secure base of risers with thrust restraints to prevent joint separation. Restraint shall be in accordance with CISPI recommendations.
- G. Brace horizontal piping 5" and larger to prevent horizontal movement. Install bracing at every branch connection and every change of direction in accordance with CISPI recommendations.

3.05 TESTING

- A. Refer to Testing paragraph of Section 20 0000 - General Mechanical Requirements.
- B. Gravity Systems:
 1. Water test may be applied to system either in its entirety or in sections. Piping shall be tightly plugged and submitted to 10 ft head of water located at highest point. Provide separate standpipe above highest point being tested or extend system to obtain required 10 ft head of water. Head shall be maintained for at least 30 minutes before inspection starts.
- C. Pressurized Systems:
 1. Water test system may be applied to system in its entirety or in sections. Test piping with water to pressure of [25 psi] [50 psi] for 2 h. No decrease in pressure allowed. Provide pressure gauge with shutoff and bleeder valve at highest point of system tested. Inspect joints in system under test.
- D. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.

- E. Do not backfill pipe until successfully tested.
- F. Testing with air will not be allowed.

END OF SECTION

**SECTION 221600
NATURAL GAS PIPING**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies natural gas piping and accessories to 5 ft outside building wall.

1.02 RELATED WORK

- A. Section 20 0520 - Excavation and Backfill
- B. Section 20 0529 - Piping and Equipment Supporting Devices
- C. Section 20 0553 - Mechanical Systems Identification

1.03 QUALITY ASSURANCE

- A. Order piping with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.
- B. Installed material not meeting specification requirements must be replaced with material that meets these Specifications without additional cost to Owner.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to insure material is undamaged and complies with specifications.
- B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C. Off-site storage agreements will not relieve Contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

1.05 SUBMITTALS

- A. Manufacturer's technical data for the following:
 - 1. Pipe and fittings
 - 2. Joints
 - 3. Valves
 - 4. Regulators
- B. Shop Drawings on items specified herein.

1.06 NATURAL GAS SERVICE

- A. Gas service, meters and regulating equipment will be installed by gas company on inlet side of meters.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials herein specified shall be new, unless otherwise noted.

2.02 BELOW GROUND PIPE, FITTINGS AND JOINTS

- A. 2" and Smaller:
 - 1. Pipe: Thermoplastic polyethylene tubing, PE 2406 or PE3408, ASTM D3350, SDR-11, rated for 80 psig working pressure at 73°F, ASTM D2513
 - 2. Fittings: ASTM D2683, socket fusion. Use transition fitting at joints between polyethylene tubing and steel with protective coating. Transition fittings shall have socket joint on polyethylene tubing side and plain beveled end on steel side.
 - 3. Joints: Socket fusion
 - 4. Trace Wire: No. 12, copper 600 V, THHN insulation
- B. Anodeless Gas Riser:

1. Acceptable manufacturers: Elster Perfection, Gastite, Georg Fischer, Lyall, or approved equal
2. Manufactured polyethylene to carbon steel transition fitting, requiring no cathodic protection for buried carbon steel pipe, socket, or butt fusion connection for polyethylene pipe, plain beveled end for carbon steel pipe, electrostatically applied epoxy coating on carbon steel pipe, CSA listed

2.03 ABOVE GROUND PIPE, FITTINGS AND JOINTS (UNDER 2 PSIG)

A. 4" and Smaller:

1. Pipe: ASTM A53, Grade A or B, Type E, or ASTM A106, Grade B, standard weight, (Schedule 40), carbon steel
2. Fittings: ASTM A197/ANSI B16.3 Class 150, black malleable iron, threaded
3. Joints: Threaded

2.04 ABOVE GROUND PIPE, FITTINGS AND JOINTS (OVER 2 PSIG)

A. 2" and Smaller:

1. Pipe: ASTM A53, Grade A or B, Type E, or ASTM A106, Grade B, standard weight, (Schedule 40), carbon steel
2. Fittings: ASTM A105/ANSI B16.11, 3000 lb forged steel, socket weld
3. Joints: Welded

2.05 UNIONS

A. Steel Pipe, 2" and Smaller:

1. Malleable iron, ground brass seat, 150 psi steam working pressure; Anvil 2125 or equivalent
2. Forged steel, spiral wound gasket seats, ASTM A105, ANSI B16.5

2.06 FLANGES

A. Steel Pipe, 2-1/2" and Larger:

1. ANSI 150 lb class forged steel flanges, ASTM A105/ANSI B16.5. Standard bolt pattern, ANSI 150 lb class 1/8" thick gasket, Type 304 stainless steel, spiral wound metal with graphite filler.

2.07 VALVES

A. Plug Valves:

1. Acceptable Manufacturers: DeZurik, Homestead, Key Port, Milliken and Resun equal to manufacturer's Figure number listed
2. 2" and Smaller:
 - a. Cast iron body, threaded, permanently lubricated bearings, bronze plug, corrosion resistant Hycar plug seal, Buna stem seal packing, lever actuator, 175 psi CWP, UL Listed. Key Port Figure 425S.
3. 2-1/2" through 4":
 - a. Cast iron body, flanged, permanently lubricated bearings, electroless nickel plated cast iron plug, corrosion resistant Hycar plug seal, Buna stem seal packing, lever actuator, 175 psi CWP, UL Listed. Key Port Figure 425F.

B. Vented Gas Pressure Regulators:

1. Acceptable Manufacturers: Fisher, Rockwell, Sensus, or American meeting capacity and performance listed
2. Valve shall be capable of 6000 cfh with an inlet pressure of 2-5 psig and an outlet pressure of 14in WC.

C. Non-Vented Gas Pressure Regulators:

1. Acceptable Manufacturers: Maxitrol 325 with VLimitter, Pietro Fiorentine "Gas Governor", or approved equal.

2. 2" and Smaller: Cast iron or cast steel body, plated steel spring, threaded, external vent limiter, 2 psi maximum inlet pressure, listed in compliance with ANSI Z21.80.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install gas piping according to requirements of this Section, local gas utility, NFPA 54 National Fuel Gas Code, AGA pamphlets and as shown on drawings.
- B. Piping through roof to be run through approved roof penetration with flashing and counter flashing.
- C. Install buried/underground polyethylene gas piping with trace wire taped to pipe along its entire route. Secure wire to pipe to prevent movement during backfilling. Extend trace wire to valve boxes and service entrance.
- D. Transition from polyethylene piping to steel piping shall occur below grade. Provide cathodic protection and corrosion protection pipe wrap for underground steel pipe.
- E. Install underground polyethylene gas piping exterior to building according to pipe manufacturer's recommendations and to meet local gas utility company's installation standards.
- F. Manufacturer's representative shall instruct workmen in proper techniques for installation of underground polyethylene gas piping and provide certification to Owner that instructions have been given and proficiency been demonstrated by Contractor for installation of that piping system. Joints must be made by "Qualified" personnel proficient in joining methods of ASTM D2513 thermoplastic gas pressure pipe.
- G. Grounding to gas piping is prohibited.
- H. Gas piping shall be installed with dirt legs adjacent to equipment and with drain tees and plugs at low points.
- I. Gas piping in plenum ceilings shall have welded joints.
- J. Install gas piping above ground in buildings. Gas piping shall not be installed below building floor or footings.
- K. Pitch horizontal piping downward at 1" per 60 ft in direction of flow toward risers or appliances. Install minimum of 4" deep dirt leg at bottom of each vertical run and at each appliance. When installing mains and branches, cap gastight each tee or pipe end, which will not be immediately extended. Take branch connections to main from top or side of main.
- L. Coat underground piping with corrosion resistant tape equal to Tapecoat H-30 and cathodically protected as specified herein. Repair breaks in tape coating caused by installation process.
- M. Make threaded joints by cutting pipe square and reaming inside. Threads shall be cut so exposed threads do not exceed 3 in number. Protect exposed threads against corrosion. Use only joint compounds approved for gas piping.
- N. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless piping is serving this equipment.

3.02 UNDERGROUND WARNING TAPE

- A. Provide warning tape for exterior buried gas lines per Section 20 0553.

3.03 PRESSURE REGULATORS

- A. Install regulators in accordance with manufacturer's instructions.
- B. Regulator shall be accessible for maintenance and protected from fire and mechanical damage. Regulator shall be supported from structure by brackets and supports.
- C. Vent(s) from vented pressure regulators or pressure safety valves shall be piped to outside. Terminate vent with protection screen and return bend. If above ground vent terminates in area subject to snow accumulation, terminate line at least 5 ft above grade. Coordinate vent routing with other trades to point of termination. Size vents in accordance with regulator manufacturer's requirements for regulator flow rate and length of run.

- D. Provide unions on both sides of regulators for removal and maintenance.
- E. Provide gas cock for pressure verification.

3.04 WELDER QUALIFICATIONS

- A. Welding procedures, welders, and welding operators for building service piping to be in accordance with certified welding procedures of National Certified Pipe Welding Bureau and Section 927.5 of ASME B31.9 Building Services Piping or AWS 10.9 Qualification of Welding Procedures and Welders for Piping and Tubing.
- B. Before metallic welding is performed, submit Welding Procedure Specification together with Procedure Qualification Record as required by Section 927.6 of ASME B31.9 Building Services Piping.
- C. Before polyethylene fusion welding is performed, submit certification that welders to be used on this project have successfully demonstrated proper welding procedures in accordance with Code of Federal Regulations, Title 49, Part 192, Section 192.285.
- D. Before welding is performed, submit Standard Welding Procedure Specification together with Procedure Qualification Record as required by Section IX of ASME Boiler and Pressure Vessel Code.
- E. Welded joints shall be made in conformance with latest provision of Code for Pressure Piping, ANSI Standard B31-8 - Gas Transmission and Distribution Systems. Welds to be made by qualified welders experienced in piping work. Welding, piping fabrication, etc. shall be in accordance with ASME Code, State Codes, and Welding Manual of Mechanical Contractors Association of America.
- F. Architect or Engineer reserves right to test work of welder employed on Project, at Contractor's/Owner's expense. If work of welder is found to be unsatisfactory, welder shall be prevented from doing further welding on project and defective welds replaced at no additional cost to Owner.

3.05 TESTING

- A. Test above ground steel gas piping with dry compressed air at 50 psi for 2 h. Soap test of each joint shall be done to detect leaks during 2 h period. No loss of pressure allowed during test period. No piping shall be concealed until successfully tested.
- B. Test underground polyethylene gas piping at 50 psi with dry air for 2 h. No loss in pressure allowed. Defective joints shall be cut out, pipe repaired, and retested. No piping may be backfilled until successfully tested.
- C. Types and extent of non-destructive examinations required for pipe welds are as shown in Table 136.4 of ASME Code for Pressure Piping, ANSI/ASME B31.1 - Power Piping. If requirements for non-destructive examination are to be other than that stated above, degree of examination, and basis for rejection shall be matter of prior written agreement between fabricator, or Contractor and purchaser.
- D. Local regulating and governing agencies may require periodic testing of seismic valve's ability to shut-off gas flow during seismic event. Follow procedures specified by local governing agency for test.

3.06 CLEANING

- A. Before actuation of gas system, flush system with dry nitrogen to ensure clean system free of oil and construction debris.

END OF SECTION

**SECTION 223314
WATER HEATING EQUIPMENT**

PART 1 - GENERAL

1.01 [RELATED WORK

- A. Section 20 0529 - Piping and Equipment Supporting Devices
- B. Section 20 0553 - Mechanical Systems Identification
- C. Section 22 1118 – Water Distribution System
- D. Section 22 0594 - Domestic Water Systems Balance
- E. Section 22 2114 - Plumbing Specialties

1.02 QUALITY ASSURANCE

- A. Water heating equipment shall conform to State and Local Codes, meet national standards, and be certified by respective organization and bear its stamp.

1.03 SUBMITTALS

- A. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials specified herein shall be new unless otherwise noted.

2.02 ATMOSPHERIC GAS FIRED TANK TYPE WATER HEATER

- A. Manufacturers: A.O. Smith, Bock, Bradford White, Lochinvar, Rheem, Ruud, State
- B. Water heater shall be high efficiency atmospheric gas fired water heater. Water heater design shall bear "CSA Design Certified" mark, have 5 yr tank warranty and have 1 yr parts warranty.
- C. Burner shall be cast iron or stainless steel with thermostat adjustment of 90°F to 180°F. Controls shall be arranged for emergency shut off in event of pilot failure.
- D. Tank shall be glass lined steel ASME rated for 150 psig. Tank shall have removable magnesium anode rod, pressure and temperature relief valve, drain valve, boiler-type hand-hole cleanout, draft hood, polyurethane insulation, painted steel jacket, inlet and outlet thermometers, and gas pressure regulator set for operation at 14" WC natural gas.
- E. Refer to Water Heater Schedule for water heater capacity required.

2.03 THERMAL EXPANSION TANK

- A. Manufacturers: Amtrol, Goulds, Wessels
- B. Expansion tank shall be precharged, diaphragm-type tank designed for hot water systems. Tank shall be ASME rated for 125 psig and come with fixed rubber bladder, air charge fitting, steel base ring stand (floor mounted tanks only), factory primed and enamel painted exterior, and ASME relief valve. Materials exposed to water to be NSF or FDA approved for potable water service.
- C. . Refer to Expansion Tank Schedule for basis of design.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install water heaters as recommended by manufacturer. Provide final connections as required. Coordinate water heater location with other Contractors.
- B. Initial start up and balancing service shall be provided by representative of manufacturer.

END OF SECTION

**SECTION 22 4000
PLUMBING FIXTURES**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section lists plumbing fixtures and accessories including method of installation.

1.02 RELATED WORK

- A. Section 22 1118 - Water Distribution System
- B. Section 22 1314 - Sanitary Waste and Storm Drainage Systems
- C. Section 22 1600 - Natural Gas Piping
- D. Section 22 6114 - Laboratory Compressed Air System
- E. Section 22 6314 - Carbon Dioxide Piping Systems
- F. Section 22 6653 - Corrosion Resistant Waste and Vent System

1.03 SUBMITTALS

- A. One package of manufacturer's technical data for all items. Submittal shall be assembled brochure, showing cuts and full detailed descriptions for each item.
- B. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials as specified shall be new unless otherwise noted.
- B. Vitreous china fixtures shall be of highest quality, non-absorbent, hard-burned, and vitrified throughout.
- C. Enameled ware shall be quality cast iron of uniform thickness and density, glazed to uniform depth and high gloss rubbed smooth, without chips or flaws, craze, or cracks, and completely acid resisting.
- D. Stainless steel fixtures shall be 302/304 types of non-corrosive steel, 18 ga self-rim for cabinet sinks, 14 ga for free standing compartment type sinks. Sink material shall have satin finish and coved corners, with faucet holes punched to match specified faucet fitting.
- E. Precast receptors and shower basins shall be terrazzo" concretebuilt up base and tile. Receptor and basin colors shall be standard colors unless otherwise noted. Assembly of drain to waste piping shall be made from floor level on which basin or receptor is installed.
- F. Insulation for traps and supplies shall be molded closed cell vinyl insulation and shall meet ASTM E84 for flame and smoke spread. Insulation shall be vandal resistant and be color as listed.

2.02 MANUFACTURERS

- A. Plumbing fixtures shall be provided from list of approved manufacturers. Home Market, Generic Broker, or Wholesaler's house brands are not acceptable.
- B. Water closets, urinals, and lavatories: American Standard, Kohler, or Zurn equal to number listed
- C. Water Closet Seats: Bemis, Beneke, Centoco, Olsonite or Zurn equal to number listed
- D. Flush Valves: Delaney, Sloan or Zurn equal to number listed
- E. Stainless Steel Sinks: Advance Tabco, Elkay or Just equal to number listed
- F. Electric Water Coolers: Elkay, Halsey-Taylor, Haws, Oasis, or Sunroc equal to model listed
- G. Service Sinks: American Standard, Eljer, or Kohler equal to number listed
- H. Mop Basins (Janitor Sinks): Fiat, Mustee, Stern-Williams, or Zurn equal to number listed
- I. Emergency Eyewashes and Showers: Acorn, Bradley, Encon, Guardian, Haws, or Speakman, equal to number listed
- J. Manual Faucets: Chicago Faucet, Delta HDF, Kohler or Moen Commercial, equal to number listed

- K. Sensor Activated Faucets: Bradley, Chicago Faucet, Kohler, Sloan, TOTO or Zurn equal to model listed
- L. Fixture Traps: Engineered Brass Company, Kohler, McGuire, or Zurn equal to number listed
- M. Insulated Traps and Supplies: McGuire or True-Bro equal to model listed
- N. Supplies and Stops: Chicago Faucet, Kohler, McGuire or Zurn equal to number listed
- O. Shower Valves and Mixing Valves: Acorn, Leonard, Powers or Symmons equal to number listed

2.03 CARRIERS AND SUPPORTS

- A. Carrier manufacturers shall be Josam, J.R. Smith, Wade, Watts or Zurn, as outlined herein, with models suitable to fixture and use intended. Provide carriers with adjustable faceplate, rectangular steel uprights and at least 3 bolt lugs for securing carrier to floor. Adjustable water closet carriers shall be either right or left, single or double, horizontal or vertical as suggested by drawings and riser diagrams.
 - 1. Water Closet: Adjustable face plate, rear support for single carries, barrier-free fixtures mounted with top of bowl at 17" from finished floor, Zurn Z-1203 and Z-1204.
 - 2. Urinal: Rectangular uprights, bearing plate, barrier-free fixtures mounted with rim 17" maximum from finished floor, Zurn Z-1222.
 - 3. Lavatory: Concealed arms, rectangular steel uprights, Zurn Z-1231-EZR-WL.

2.04 WATER CLOSETS AND URINALS

- A. Provide appropriate gaskets for fixture installation.
- B. Provide bolts with chromium plated caps, nuts and washers.

2.05 WATER CLOSET SEATS

- A. Heavy duty, elongated bowl, open front, plastic seat less cover, with stainless steel self-sustaining hinge, white, Bemis 1955-SSCT.

2.06 PROTECTIVE PIPE INSULATION COVERS

- A. Manufactured plastic wraps for covering plumbing fixture hot and cold water supplies, trap and tailpieces shall comply with Americans with Disabilities Act (ADA) requirements.

2.07 PLUMBING FIXTURES

- A. Refer to schedule on drawings for detailed fixture selection criteria not contained herein.

2.08 LABORATORY FIXTURES

- A. Refer to schedule on drawings for detailed fixture selection criteria not contained herein.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install plumbing fixtures as recommended by manufacturer. Caulk around fixtures mounted on irregular surfaces such as tile or stone with silicone sealant, same color as fixture.
- B. Support fixtures with proper carrier for each use. Insure that carrier is solidly anchored to prevent rocking whatever piping is used. Anchor bolts in carrier foot shall extend 3" minimum into concrete slab.
- C. Fixture carriers shall be suitable for securing each plumbing fixture in place solidly, yet allowing its removal when necessary. Carriers shall be capable of mounting "Barrier Free" fixtures at suitable heights.
- D. Install each fixture with trap easily removable for servicing and cleaning. Install fixture stops in readily accessible location for servicing.
- E. Install barrier free fixtures in compliance with local code and Federal ADA Accessibility Guidelines. Install barrier free lavatory traps parallel and adjacent to wall and supplies and stops elevated to 27" above finished floor to avoid contact by wheelchair users.

- F. Return fixture waste and supply piping into wall as high as practical under fixture. Provide accessible shutoff in fixture supply. Protect "barrier free" supply and drain piping with white colored wrap neatly trimmed to prevent contact with hot or sharp surfaces by user.
- G. Coordinate with Electrical Contractor for electronic sensor wiring necessary to install "sensor" operated fixtures. Provide "shockstops" at supplies to solenoid activated fixtures.
- H. Provide individual supplies to fixtures and rough-in fixture piping with adequate support to prevent movement fore, aft and laterally. Provide additional blocking as required.
- I. Install flush valves for barrier-free water closets with operator handle facing wide side of toilet stall.
- J. Provide unions at water connections to drinking fountains and electric water coolers.

3.02 LABORATORY BENCH AND CUP SINKS

- A. Set sink, faucet, eyewash, drain and tailpiece.
- B. Make final waste, vent and water connections to fixture.
- C. Purified water outlets do not require fixture stops.

3.03 LABORATORY CASEWORK OUTLETS

- A. Set fixtures in predrilled casework.
- B. Make final connection of fixture to service piping.

3.04 FUME HOODS

- A. Set cup sink, faucet, drain and tailpiece.
- B. Make final connections to service piping or pre-piped hood. Vent piping for cup sink will not be pre-piped.

3.05 PROTECTION

- A. Protect finished surfaces of fixtures from accidental damage or discoloration by use of protective covering.

3.06 CLEANING

- A. Prior to Owner acceptance, clean fixtures with compounds recommended by manufacturer and remove stains and marks from surrounding walls and countertops.

END OF SECTION

**SECTION 22 6114
LABORATORY COMPRESSED AIR SYSTEM**

PART 1 - GENERAL

1.01 DESCRIPTION

1.02 RELATED WORK

- A. Section 20 0513 - Motors
- B. Section 20 0529 - Piping and Equipment Supporting Devices

1.03 SUBMITTALS

- A. Shop drawings on items specified herein.

1.04 PRODUCT DELIVERY

- A. Deliver pipe and equipment properly packaged to protect against shipping and handling damage.
- B. Installed pipe shall be sealed during construction to prevent construction debris from entering piping system.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials herein specified shall be new unless otherwise noted.

2.02 PIPE AND FITTINGS

- A. Above Ground
 - 1. Copper
 - a. Pipe:
 - 1) Copper tube, Type Lhard temper, cleaned and capped, ASTM B280, marked "ACR" or similar in accordance with ASTM
 - b. Fittings: Wrought copper, solder joint, pressure rated, cleaned and bagged, ANSI B16.22
 - c. Joints: Brazed, silver solder, BCu-3 or BCuP-5 type, AWS A5.8, 1250°F melting point minimum.

2.03 UNIONS

- A. Copper 3" and smaller:
 - 1. Wrought copper union, Nibco 633-W

2.04 VALVES

- A. Ball Valves:
 - 1. Acceptable manufacturers: Apollo, Nibco, Watts
 - 2. 3" and Smaller:
 - a. Full port, 2-piece, bronze body, chrome plated bronze ball, teflon seats, blowout-proof stem, and threaded or soldered joint, Watts FBV or FBVS
 - b. Full port, 3-piece, bronze body, stainless steel ball, PTFE seats, stainless steel trim, blow-out proof stem, 6" tube extension, oxygen cleaned and bagged, quarter turn handle, 600 psi CWP; Nibco CS-595-YX-66-EC Series, Apollo 82 240 Specia Female through 2"
- B. Check Valves
 - 1. Acceptable manufacturers: Apollo, Nibco, Watts
 - 2. 2" and smaller:
 - a. Spring loaded, bronze or bronze/stainless steel body, 316 stainless steel spring, straight through flow, shipped bagged and oxygen clean. Apollo Ball-Cone Model 62-100-57.

2.05 PRESSURE REGULATORS

- A. Manufacturers: Cashco, Fisher, Jordan or approved equal
- B. Bronze body and spring case, direct acting valve, manual adjustment screw with top nut, stainless steel trim, resilient valve seat, cleaned for oxygen service. Cashco Model D Series or approved equal, Jordan Mark 68G Series. Refer to schedule on drawings for performance criteria.

2.06 AUTOMATIC DRAIN DEVICE

- A. Acceptable manufacturers: Jorc or approved equal
- B. Automatic condensate removal device with zero air loss during condensate discharge. Drain device shall have Viton seals and shall have 120 V power connection.
- C. Basis of design is Jorc "Smart Guard Ultra" capable of up to 3600 scfm at up to 230 psig at 34-112°F.

2.07 OIL-LESS RECIPROCATING AIR COMPRESSOR (AC-1)

- A. Manufacturers: Atlas Copco, Ingersol-Rand, Powerex, Quincy, Squire-Cogswell
- B. Air compressor shall be duplex air cooled, oil less reciprocating unit. Compressor shall be , tank mounted and shall be factory wired, piped and tested prior to delivery to jobsite.
- C. Compressors shall operate in lead/lag/alternate configuration. Panel for compressor control shall be included with package.
- D. Each compressor shall be provided with following components:
 - 1. 10 micron inlet filter
 - 2. Air intake silencer
 - 3. Discharge air check valve
 - 4. Manual compressor isolation valve
 - 5. Air cooled aftercooler
 - 6. 230 or 460 V, 3 Ph motor meeting efficiencies listed in 20 0513
 - 7. Capacity of 80 cfm at 100 psig
 - 8. Control panel:
 - a. Fused disconnect switches
 - b. Magnetic across-the-line starters with thermal overload protection
 - c. Automatic pump start and stop
 - d. Automatic pump lead/lag controls
 - e. Automatic alternator, controlled by time clock
 - f. 120 volt control transformer
 - g. Compressor discharge pressure gauge
 - h. Power indicator
 - i. Pump running indicators
 - j. High temperature shut-down switch
 - k. Individual hand-off-auto switches
 - l. Motor overload alarm.
- E. Basis of design: Refer to schedule on drawings for detailed fixture selection criteria not contained herein.

2.08 REFRIGERATED AIR DRYER

- A. Manufacturers: Arrow by McIntire, Deltech, Hankinson, Zeks
- B. Air dryers shall be refrigerated units piped in parallel. Air dryers shall be factory wired, piped and tested prior to delivery to jobsite.
- C. Air dryers shall be provided with following components:
 - 1. Simplex inlet coalescing filter with automatic drain device
 - 2. Simplex outlet particulate filter
 - 3. Hot gas bypass
 - 4. Air cooled condensing unit

5. Capacity of 80 scfm at 40°F dewpoint discharge air
6. 120 V, 1 Ph power connection
7. NEMA 4 control panel with following features:
 - a. Power indicator
 - b. Compressor on indicator
 - c. High air temperature alarm
 - d. Locally mounted dewpoint indicator
 - e. High humidity alarm
 - f. Extra set of dry contacts for alarm monitoring to Building Automation System
- D. Basis of Design: Refer to schedule on drawings for detailed fixture selection criteria not contained herein.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install compressed air piping as shown on drawings and details.
- B. Provide low point drain valve at bottom of risers. Pipe mains shall not be trapped between connection at riser and last branch take-off. Branch take-offs to rooms or individual spaces shall be from top of main.
- C. Cut copper tube square and ream before assembly. Keep piping capped during construction to prevent intrusion of construction debris.
- D. Support piping drops through finished ceiling from structure above to prevent any lateral or up/down movement. Other outlet drops shall be supported from walls, columns, or workbenches using appropriate hangers, anchors, or Unistrut.
- E. Install unions on equipment side of shutoff valves for items such as: air dryers, receiver, compressors, filters, and similar equipment requiring periodic replacement or maintenance.
- F. Install vented valve for lock-out/tag-out at connection to equipment. Vented valve shall meet OSHA requirements for disabling power source and bleeding downstream energy.
- G. Install temporary plugs and caps on openings during construction phase.

3.02 COPPER TUBING

- A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.
- B. Soldered Copper Joints:
 1. Use non-acidic and lead free flux on cleaned pipe and fittings for soldered joints.
 2. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
 3. Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.
 4. Apply heat carefully to prevent damage to pipe, fittings and valves.
 5. Follow manufacturer's recommendations when heating valves and equipment for soldered connections.
- C. Brazed Copper Joints:
 1. Brazed joints shall be ASTM Grade 4 or 5 and have melting point at approximately 1250°F. Solder impurities shall not exceed 0.15%.
 2. Tubing shall be delivered to site with original mill caps in place.
 3. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
 4. Joints shall be cleaned and polished before brazing.
 5. Flux of any type shall not be used.
 6. Apply heat carefully to prevent damage to pipe, fittings and valves. Disassemble valves where possible to prevent damage to seats during brazing.

7. Purge tube with nitrogen during brazing procedure. Provide manual shut-off valve and check valve as required for purge gas.

3.03 AIR COMPRESSORS

- A. Provide wiring necessary for controls and automation systems interface.
- B. Air compressor package with components and accessories shall be furnished by one manufacturer. Install components according to manufacturer's recommendations. Consult manufacturer-furnished piping diagrams for interconnecting piping of system components.
- C. Verify that all compressor functions are properly functioning.
- D. Adjust compressor stop, start, staging, and alternation functions.
- E. Verify that the automatic drain valve is properly functioning.

3.04 TESTING

- A. Refer to testing paragraph of Section 20 0000 - General Mechanical Requirements.
- B. Air piping shall be tested at 150 psig for 2 h prior to connection of laboratory fixtures. Soap test each joint to detect leaks during test period. No loss of pressure allowed during test period. Defective joints shall be cut out and replaced. Air piping shall be re-tested at 100 psig for 8 h after final connection of laboratory fixtures.
- C. Air compressor equipment shall be delivered pre-assembled and tested by equipment manufacturer.
- D. Verify proper signal transmission for each condition specified to Building Automation Controller.

3.05 CLEANING

- A. All pipe, fittings and valves will be cleaned by manufacturer. On- or off-site cleaning of any components by Contractor is not allowed. Any components, which have become contaminated, will not be used on any clean systems. They may be used in laboratory vacuum or any water system using copper pipe or fittings.
- B. Before system is placed into use, flush piping with product air to remove foreign particles.

3.06 WARRANTY

- A. Manufacturer shall warrant air compressor package and components complete, for period of 2 yrs from date of start-up.

END OF SECTION

**SECTION 226314
CARBON DIOXIDE PIPING SYSTEMS**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies carbon dioxide piping and related accessories. Select appropriate gases.

1.02 RELATED WORK

- A. Section 20 0529 - Piping and Equipment Supporting Devices
B. Section 20 0553 - Mechanical Systems Identification
C. Section 22 4014 - Equipment by Others
D. Section 22 6114 - Laboratory Compressed Air System

1.03 SUBMITTALS

- A. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.01 PIPE

- A. Above Ground:
1. "Clean" Copper:
 - a. Pipe: Copper tube, hard temper, cleaned and capped, ASTM B819, marked "MED" or similar in accordance with ASTM
 - b. Fittings: Wrought copper or bronze solder joint, pressure rated, cleaned and bagged for oxygen service, ANSI B16.22
 - c. Joints: Brazed, silver solder, BCuP-5, AWS 5.8, 1250°F melting point minimum
 2. Relief Vent Piping:
 - a. Pipe: Copper tube, Type L, hard temper, ASTM B-88
 - b. Fittings:
 - 1) Wrought copper or bronze, solder joint, pressure rated, ANSI B16.22
 - 2) Cast bronze, solder joint, pressure rated, ANSI B16.18
 - c. Joints:
 - 1) Solder: lead free (<0.2%), ASTM B32
 - 2) Flux: ASTM B813

2.02 UNIONS

- A. Copper 3" and smaller:
1. Wrought copper union, cleaned and bagged for oxygen service, Nibco Fig. 633-W. Mueller brass equal.

2.03 VALVES

- A. Copper:
1. Ball Valve
 - a. Size 2" and Smaller:
 - 1) Acceptable manufacturers: Apollo, Nibco, Watts
 - 2) Full port, 3-piece, stainless steel ball, ptfe seats, stainless steel trim, blow-out proof stem, 6" tube extension, oxygen cleaned and bagged, quarter turn handle, 600 psi cwp rated, Apollo 82-240 Special Femalenibco S-595-YX-66 series
 2. Check Valves
 - a. Acceptable manufacturers: Apollo, Nibco, Watts
 - b. 2" and smaller:

- 1) Spring-loaded, bronze or bronze/stainless steel body, 316 stainless steel spring, straight through flow, oxygen cleaned and bagged. Apollo ball-cone model 62-100-57.

2.04 PRESSURE REDUCING VALVES

- A. Acceptable Manufacturer: AGA/Linde, Norgren, Tescom
- B. Regulator shall be made from high purity brass or stainless steel barstock and have Hastelloy diaphragms. Regulator shall be cleaned and bagged for oxygen service. Regulator shall have 0-80 psig outlet pressure range and be provided with outlet pressure gauge. Gauge shall be selected such that operating pressure is in center of gauge pressure range. Inlet and outlet connections shall be 1/4" female NPT minimum.
- C. Refer to schedule on drawings for flow rate and pressure requirements of each regulator.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Carbon Dioxide Piping: carbon dioxide piping shall be installed according to requirements of CGA pamphlets and as shown on drawings.
- B. Piping shall be installed above ground in buildings. Protect pipe openings during construction to prevent introduction of dirt and debris.
- C. Shutoff valves shall be accessible in case of emergency; installed minimum of 5 ft from each piece of equipment.
- D. Identify gas services during installation so that the chance for cross over of one gas service to a different terminal unit is avoided. Do not depend on test procedure listed herein to identify cross connections.
- E. Manifold relief valves shall be piped to exterior or other appropriate points. Avoid discharging close to windows, doors and air intake louvers.
- F. Changes in direction shall be made by use of fittings. No pipe bending allowed. Pipe size reductions shall be by use of reducing fittings, no bushings allowed.

3.02 COPPER TUBING

- A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.
- B. Brazed Copper Joints:
 1. Brazed joints shall be ASTM Grade 4 or 5 and have melting point of approximately 1250°F. Solder impurities shall not exceed 0.15%.
 2. Tubing shall be delivered to site with original mill caps in place.
 3. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
 4. Joints shall be cleaned and polished before brazing.
 5. Flux of any type shall not be used.
 6. Apply heat carefully to prevent damage to pipe, fittings and valves. Disassemble valves where possible to prevent damage to seats during brazing.
 7. Purge tube with nitrogen during brazing procedure. Provide manual shut-off valve and check valve as required for purge gas.
- C. Soldered joints shall be made with approved non-acidic flux on cleaned pipe and fittings. Solder shall fill joints by capillary action. Solder shall cover joints by capillary action. Solder shall cover joint periphery. Wipe joints clean.

3.03 FLUSHING

- A. Before actuation of air supply, systems shall be flushed with dry compressed air to ensure a clean system free of oil and construction debris.
- B. Purge piping with its service gas before placing the system in operation.

3.04 CLEANING

- A. Piping and components that are provided "Cleaned for Oxygen Service" shall not require cleaning. Flush system with source gas until 100% concentration of service gas is verified at all outlets.
- B. For components not provided "Cleaned for Oxygen Service" and components where cleanliness has been compromised, pipe and fittings shall be thoroughly cleansed of oil, grease, dirt or other contaminating materials by washing in a hot solution of sodium carbonate or trisodium phosphate mixing in proportions of 1 pound to 3 gallons of water. Scrubbing shall be employed where necessary to obtain complete cleaning. After washing, materials shall be rinsed thoroughly with clean hot water and dried with dry nitrogen. After cleaning, tubing, fittings, and valves shall be plugged or wrapped until item is to be installed. Particular care must be exercised in handling and in conditions of tools used to prevent oil and grease being introduced. If contamination has occurred, affected items must be rewashed.

3.05 TESTING

- A. Refer to testing paragraph of Section 20 0000 - General Mechanical Requirements.
- B. Pressurize piping system prior to connection of laboratory fixtures and check for leakage by examining each joint by means of Oxweld No. 23 Leak Test Solution or other non-frothing solutions approved for this purpose.
 - 1. Gaseous carbon dioxide piping shall be pressurized with dry nitrogen at 150 psi.
- C. Test pressure shall remain in piping for at least 2 h. Source pressure shall be shut off and pipe temperature at beginning and end of test shall be recorded. Pressure changes, other than that caused by temperature change, will not be permitted.
- D. Provide final pressure test at 100 psig for 8 h after connection of laboratory fixtures.
- E. Test operation of pressure switches and verify that signals are properly transmitted.
- F. Containment piping shall be pressurized with oil free compressed air at 5 psig for 2 h. Containment piping shall not be pressure tested until carrier pipe has passed pressure testing.

END OF SECTION

**SECTION 226653
CORROSION RESISTANT WASTE AND VENT SYSTEM**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies pipe, fittings, equipment and methods for corrosion resistant waste and vent piping system installed to 5 ft outside the building wall.

1.02 RELATED WORK

- A. Section 20 0529 - Piping and Equipment Supporting Devices

1.03 SUBMITTALS

- A. Shop drawings on items specified herein.
- B. Submit Manufacturer's technical data for the following:
 - 1. Pipe and fittings
 - 2. Joints
 - 3. Floor drains
 - 4. Cleanouts

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Use new materials unless otherwise noted.

2.02 PIPE

- A. Underground:
 - 1. Chlorinated Polyvinyl Chloride (CPVC):
 - a. Pipe: Schedule 40, ASTM D1784, and ASTM F2618
 - b. Fittings: Drain, waste, and vent (DWV) pattern, ASTM D3311
 - c. Joints: Solvent cement, ASTM F493
 - d. Manufacturers: Charlott "ChemDrain", Spears "LabWaste"
- B. Above Ground:
 - 1. Chlorinated Polyvinyl Chloride (CPVC):
 - a. Pipe: Schedule 40, ASTM D1784, and ASTM F2618
 - b. Fittings: Drain, waste, and vent (DWV) pattern, ASTM D3311
 - c. Joints: Solvent cement, ASTM F493
 - d. Manufacturers: Charlotte "ChemDrain", Spears "LabWaste"

2.03 ADAPTERS

- A. Provide where indicated and as necessary; glass to plastic compression coupling, plastic to metal mechanical joint, or glass to metal mechanical joint and/or compression coupling.
- B. Plastic to plastic 1" through 4": Fernco Proflex 3000 Series shielded coupling with neoprene gasket, stainless steel shield, and stainless steel clamping bands.
- C. Stainless Steel to Polypropylene (1" to 10"): 316L stainless steel shielded coupling with EPDM inner gasket, and 316 stainless steel fasteners. Teekay Type IV stepped transition coupling or approved equal.
- D. Submit adapter fittings for approval prior to installation.

2.04 CLEANOUTS

- A. Corrosion resistant materials similar to piping materials. Refer to Cleanout Schedule on drawings.

2.05 FLOOR DRAINS

- A. Refer to Drain and Cleanout Schedule.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install piping neat and orderly; accomplish changes of direction using proper pipe fittings. Connect to sinks, cup sinks, floor drains, and other devices as shown on drawings. Conceal piping unless noted to be exposed in reagent rack. Piping within casework shall be coordinated with casework supplier.
- B. Pitch vent piping to waste line. Install horizontal waste piping with minimum pitch of 1" in 4 ft; except piping 3" and larger may pitch 1" in 8 ft. Make changes in direction of flow by use of drainage pattern fittings.
- C. Set floor drains level and at low points. Protect weep holes from filling with concrete. Clamp safing to drain body for proper drainage.
- D. Install cleanouts as shown on drawings. Locate cleanout access cover so that snake of 100 ft can be properly used.
- E. Provide caps and plugs on open pipe ends during construction phase to prevent construction debris from entering pipe.
- F. Provide necessary transition fitting and couplings required when changing from one piping material to dissimilar material.

3.02 PLASTIC PIPING

- A. Install plastic pipe and fittings as recommended by respective manufacturer. Fuse plastic pipe joints with surrounding temperature above freezing using equipment supplied by pipe manufacturer. Adhere to instructions for fusing as published by manufacturer. Instructions for fusing shall be kept on site.
- B. Install mechanical joints in accordance with instructions from pipe/fitting manufacturer. Use materials of same manufacturer, especially made for mechanical jointing. Use pipe and fittings with factory cut groove, except pipe may be grooved in field using equipment and methods as recommended by manufacturer of pipe. Use hangers on each side of mechanical couplings.
- C. Do not install PP material in plenum space. Refer to HVAC drawings to determine plenum spaces.
- D. Use special precautions and approved/listed systems when PP material penetrates fire resistive or smoke barrier. Refer to Section 20 0573 - Mechanical Systems Firestopping.
- E. Do not use plastic pipe when high temperature (above 100°F) water (at autoclaves, sterilizers, glasswashers, and similar devices) is discharged to receptor or drain. Provide minimum of 25 ft of PVDF or stainless steel piping material downstream of high temperature drain discharge point.

3.03 TESTING

- A. Refer to Testing paragraph of Section 20 0000 - General Mechanical Requirements.
- B. Water test may be applied to system either in its entirety or in sections. Piping shall be tightly plugged and submitted to 10 ft head of water located at highest point. Provide separate standpipe above highest point being tested or extend system to obtain required 10 ft head of water. Head shall be maintained for at least 30 minutes before inspection starts.
- C. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.
- D. Do not backfill pipe until successfully tested.
- E. Testing with air will not be allowed.

3.04 CLEANING

- A. After successful pressure test, clean and flush piping system to eliminate debris in drainage system.

END OF SECTION

SECTION 22 6714.13
PLASTIC PIPING FOR HIGH PURITY SERVICE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section covers requirements for procurement, installation, inspection, and sanitization of piping, fittings, valves, and specialties for High Purity Water (HPW) service: Deionized Water (DI) and Reverse osmosis water (RO).
- B. High purity piping is defined as piping downstream of reverse osmosis unit (RO). Refer to Section 22 1118 (Water Distribution System) for piping prior to the RO unit.

1.02 RELATED WORK

- A. Section 20 0529 - Piping and Equipment Supporting Devices
- B. Section 20 0573 - Mechanical Systems Firestopping
- C. Section 22 6720.13 - High Purity Water System Equipment

1.03 SCOPE OF WORK

- A. Contractor shall be responsible for procurement, installation, inspection, and sanitization of piping system.
- B. Contractor shall provide personnel trained and experienced in installation of selected manufacturer's piping system. If personnel are not experienced at start of installation, piping manufacturer's representative shall train Contractor prior to installation. Training certification and experience record is required.
- C. Contractor shall submit documentation on components proposed for system and shall obtain approval prior to purchase or fabrication of those components.
- D. Contractor shall inspect system and provide documentation to demonstrate that system is installed according to Specification, is leak free, and has been sanitized according to procedure.

1.04 BASIS OF DESIGN

- A. Service: HPW water
 - 1. Scope: Piping downstream of storage tank
 - 2. Process Fluids: water with resistivity of 1.0 megohm; 1% peracetic acid solution
 - 3. Operating Pressure/Temp. 100 psig at 80°F
 - 4. Piping System
 - a. Design Pressure: 150 psig at 100°F for components
 - b. Material: LXT PVC as specified below.
 - 1) Joining method: Solvent weld
 - 2) Elastomer: EPDM
- B. Service: RO water
 - 1. Scope: Piping downstream of reverse osmosis unit
 - 2. Process Fluids: water with resistivity of 0.4 megohm; 1% peracetic acid solution
 - 3. Operating Pressure/Temp. 100 psig at 80°F
 - 4. Piping System
 - a. Design Pressure: 150 psig at 100°F for components
 - b. Material: CPVC as specified below
 - 1) Joining method: Solvent weld
 - 2) Elastomer: EPDM
- C. Service: Non-potable water
 - 1. Scope: Piping between backflow preventer and reverse osmosis unit
 - 2. Process Fluids: Tap water
 - 3. Operating Pressure/Temp. 100 psig at 80°F

4. Piping System:
 - a. Required Pressure Rating: 150 psig at 100°F for components
 - b. Material: CPVC as specified below
 - 1) Joining method: Solvent weld
 - 2) Elastomer: EPDM

1.05 SUBMITTALS

- A. Submit the following items prior to purchase:
 1. Product Data:
 - a. Pipe, fittings, & joints
 - b. Identification of joining method and fusion equipment
 - c. Valves
 - d. Specialty items
 - e. Instrumentation
 2. Reports: Detailed Sanitization Procedure (see Part 3.1).
 3. Certifications: Training certification for installation personnel
- B. Provide the following documentation with system delivery:
 1. Pressure Test Report
 2. Sanitization Records

1.06 DELIVERY

- A. Pipe, fitting, and components shall be furnished with plastic end-caps/plugs to prevent contamination and damage.
- B. Pipe, fittings, and components shall be handled and shipped so as to protect from contamination and damage.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. CPVC: Charlotte, Georg Fischer, Spears or approved equal
- B. Low-Extractable PVC: Harvel LXT, Spears LXT

2.02 GENERAL

- A. Piping, fittings, and valves that are to be heat fused shall be products of same manufacturer.
- B. Piping, fittings, valves, gaskets and accessories shall be compatible with Design Conditions in Part 1.5 as stated above.
- C. Dimensions of end connections for valves shall be compatible with pipe and fittings.
- D. Materials in contact with water shall be FDA approved for sanitary product contact surfaces.
- E. Pipe and fittings shall be permanently identified with production lot and wall thickness or pressure rating.
- F. Piping, fittings, valves, and components shall be manufactured in dedicated equipment in clean environments and bagged.

2.03 PIPE, FITTINGS, & JOINTS

- A. Chlorinated Polyvinyl Chloride (CPVC)
 1. Pipe: CPVC, Schedule 80, meeting requirements of ASTM F-441 and F-439 and manufactured from CPVC that meets requirements of D-1784 for Class 23447-B
 2. Fittings: CPVC, Schedule 80, meeting requirements of ASTM F-441 and F-439 and manufactured from CPVC that meets requirements of D-1784 for Class 23447-B, female socket ends
 3. Flanges: PVC flanges conforming to ANSI B1 6.5, Class 150

4. Solvent Cement: solvent cement shall conform to ASTM F-493 and to NSF International for use on potable water systems. (Threaded fittings are to be used only where required to connect to equipment.)
- B. Low-Extractable Polyvinyl Chloride (LXT PVC):
1. To insure uniform installation fit, piping system components shall be products of one manufacturer.
 2. Pipe and Fittings: Low-extractable PVC specifically compounded for high purity water application, Schedule 80, socket pattern fittings.
 3. Joints:
 - a. Low-extractable PVC solvent cement, specifically compounded for high purity water application and low-extractable PVC pipe.
 - b. Breakable Joints: Tri-Clamp with Viton Sanitary gasket.
 - c. Connections at equipment (only)
 - 1). Flange adapter with PVDF coated steel flange ring with boltholes per ANSI B16.5, Class 150 pattern.
 - 2). For mating with FRP flange, flat gasket shall be Garlock "Stress Saver", PTFE, or approved equal.
 - 3). For mating with stainless steel flange, flat gasket shall be Garlock Gylon 3545.
- A. General
1. Valve type shall be as indicated on flow diagram.
 2. Valves shall be same material and manufacturer as piping.
 3. Valves shall conform to Basis of Design in Part 1.5 above.

2.04 VALVES

- A. LXT PVC Valves:
1. General
 - a. Manufacturers: same as selected tubing.
 - b. Body: Low-extractable PVC.
 - c. Design Conditions: as per Part 1.5 above.
 2. Ball Valves: True union type, full port, Viton seals, Teflon seats.
 3. Sampling valves: Same as ball valves.
 4. Self Contained Pressure Regulating Valves
 - a. PTFE, EPDM backed, diaphragm and Viton O-rings.
 - b. Relief valves to be George Fisher V85 or equal.
 - c. Retaining (back pressure) valves to be [George Fisher V86] [Jordan Steriflow Mark 95].
 - d. Reducing valves to be George Fisher V82 or equal.
 - e. Sizing is per Equipment Schedule.
 5. Check Valves: Ball check valves, Viton seals, PVC ball.
- B. CPVC Valves
1. Diaphragm Valves
 - a. Weir type, self-draining, PTFE diaphragm backed by EPDM, non-rising stem, position indicator, stroke limit stops.
 - b. Size 2" and smaller: Georg Fischer type 515
 - c. Size 2-1/2" and larger: Georg Fischer type 317
 2. Ball Valves
 - a. True union type, full port, FPM o-rings, Teflon seats
 - b. Georg Fischer type 546
 3. Sampling valves

- a. Needle valve for sampling, Teflon seals
- 4. Check Valves
 - a. Ball check valves, Viton seals, CPVC ball

2.05 SPECIALTY ITEMS

- A. Faucet Connections
 - 1. Tubing for connection to lab faucets shall be polypropylene, or PFA tubing, 3/8" OD; 0.062" wall, rated to at least 150 psig at 80°F. Polypropylene tubing shall be made from virgin copolymer conforming to FDA requirements for food contact.

2.06 INSTRUMENTATION

- A. Instrumentation Specifications are covered in Section 22 6720.13.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install and inspect piping and accessories as per Contract Documents and recommendations of equipment manufacturers.
- B. Provide installation personnel who are trained and experienced with assembly of selected piping in high purity systems.
- C. Provide diaphragm valves or type of valves as indicated on drawings.
 - 1. Inspect delivered components to verify conformance to specification and to check for evidence of damage or contamination. Do not use suspect materials.
- D. Maintain high level of cleanliness during handling and installation.
 - 1. Prior to starting work, identify areas that will be used for storage and fabrication, and take measures to prevent contamination from adjoining areas.
 - 2. Handle and store tubing, fitting, and components in a manner that prevents impact damage, excessive stress, and contamination.
 - 3. Maintain manufacturer's protective packaging in place until immediately prior to use.
 - 4. Keep openings on assemblies sealed during fabrication to prevent contamination prior to final installation.
- E. Install piping using minimum number of joints.
- F. Monitor and inspect installation process to ensure:
 - 1. Conformance with this Specification.
 - 2. Compliance with manufacturer's requirements.
 - 3. Piping is supported as specified.

3.02 INSTALLATION

- A. CPVC and LXT Joint Fabrication
 - 1. Perform joining in strict accordance with manufacturer's recommended procedures. Cut piping in strict accordance with manufacturer's recommended procedures.
 - 2. Clean components prior to fusion conscientiously and in strict compliance with Manufacturer's recommendations for high purity services.
 - 3. Form joints by solvent welding in accordance with appropriate parts of ASTM D-2855, using solvent cement conforming to ASTM F-493 and to NSF International for use on potable water systems.
 - 4. Use union joints only where indicated on drawings or where necessary to connect to accessories and equipment. Verify that o-ring is correctly indexed prior to tightening. Tighten hand tight only; do not use tools. Tighten flanged connections in strict accordance with manufacturer's recommendations.
 - 5. Use threaded connections only if no other option for connecting to equipment.
- B. Configuration
 - 1. Install tubing so that there are no undrainable pockets.

2. Orient diaphragm valves per manufacturer's instructions to ensure complete drainage.
 3. Install check valves and orifice plates in vertical sections. If installation in horizontal is required, provide eccentric valve or plate and orientate properly.
 4. Provide low point drains and high point vents in compliance with drawings and Engineering review of isometric drawings.
 5. Rough or sharp edges must not be in contact with pipe.
 6. Erect tubing without spring or force. Connect to equipment such that stress is not transferred to equipment.
 7. Install all tee connections so as to minimize dead leg. Distance from sealing point on branch to inside of main line wall shall be less than 2 feet.
 8. Route lines so as to accommodate thermal expansion where required. Provide supports appropriate for thermal expansion. Install supports so that movement of piping due to thermal expansion is not impeded.
- C. In-Line Devices
1. Locate and orient in-line specialty items and instrumentation so as to allow for access after insulation is installed, including:
 - a. Access for maintenance and calibration.
 - b. Viewing of gauges by operating personnel.
 - c. Clearance for removal of regularly replaced components (filter elements, UV lamps, etc.)
 - d. Convenient operator access to sample valves and insertion of sampling container.
 2. Install in-line specialty items and instruments such that they are free draining.
 - a. Install restriction orifices in vertical section of pipe. Provide orifice that is eccentric drilled and orientate with hole at low point if orifice must be installed in horizontal pipe.
 - b. Install in-line specialty items and instruments in strict accordance with manufacturer's instructions.
 - c. Install sensors for conductivity and resistivity in run of a horizontal tee with flow exiting upward branch.
 - d. Provide length of straight pipe upstream and downstream of flowmeters. As specified by manufacturer.
 - e. Install pressure regulators and backpressure regulators with at least 10 pipe diameters of straight pipe upstream and downstream of regulator.
 - f. Install sanitary orifice plates in sanitary unions or in Tri-Clamp joints as indicated on drawings. Clearly tag orifice location.
 - g. Securely support relief valves and relief discharge lines.
- D. Penetrations
1. Fire-Rated walls:
 - a. Provide firestopping per Section 20 0700 - Mechanical Systems Firestopping.

3.03 USE POINT CONNECTIONS

- A. Faucets
1. Install a reducing tee in distribution line with 1/2" outlet and fuse 1/2" diaphragm valve directly on tee outlet.
 2. Connect outlet of valve to faucet with 3/8" polypropylene or PFA tubing.
 3. Use shortest length of tubing as possible.
- B. Equipment
1. Install a reducing tee in distribution line with outlet size indicated on distribution drawing. Fuse 1/2" diaphragm valve directly on tee outlet.
 2. Install piping per size from valve to equipment.

3.04 TESTING

- A. Inspection
 - 1. Visually inspect all joints and verify that they comply with manufacturer's criteria for a properly formed joint.
- B. Hydrotest
 - 1. Execute all pressure testing safely.
 - a. Do not pressurize plastic piping with gas.
 - b. Isolate equipment or instrumentation that cannot to be exposed to test pressure.
 - c. Notify personnel with access to system that testing is to take place. Tag each use point to indicate that valve is not to be used.
 - d. Ensure that air is completely vented from system to avoid a hazardous condition.
 - e. Pressurize system gradually.
 - f. Provide controls to prevent pressure from exceeding specified test pressure.
 - 2. Ensure that cleanliness of system is not compromised.
 - a. Provide water for testing and flushing that has quality equal to or better than service water.
 - b. When performing preliminary testing of sections of system, after test is complete flush all water out of system and ensure that it drains completely. Close all openings in system after draining.
 - 3. Execute final acceptance test on completed piping system.
 - a. Do not insulate or conceal piping until testing is complete.
 - b. Test system in sections or as a whole, but all joints need to be covered in test.
 - c. Ensure that air is completely vented from system.
 - d. Pressurize gradually and hold system at 100 psig for 4 hours. An initial pressure decrease will occur due to pipe elongation after pressurization. After 4 hours, pressure loss will stabilize, and pressure must then hold at test pressure without a loss of 1% over period of one hour to pass test.
 - e. Monitor pressure with gauge located near bottom of system that is readable to at least plus or minus 1 psi.
 - f. Note if pressure drops more than 1% over test period and determine source of leakage.
 - 1) Cut out and reinstall defective joints.
 - 2) Hand tighten wing nuts on sanitary clamps if required. If leakage continues, install new gasket. Do not tighten using tools.
 - 3) Retest.
 - 4. Provide written certification that includes identification of portion of system tested, date, time, test criteria, test medium and pressure, duration, and name and title of person responsible for test.

3.05 SANITIZING/FLUSHING

- A. General
 - 1. Perform sanitization after inspection, documentation, and acceptance of system. If chemical sanitation is not required then this procedure will be used for flushing, without addition of sanitant.
 - 2. Prior to sanitization, slowly fill system with water while venting air from system. Continue to check that all air has been vented after water is recirculating.
 - 3. Adjust any pressure regulators to their preliminary setpoints.
 - 4. Perform sanitization immediately prior to placing system in operation and coordinate with Owner's representative.
 - 5. Safety:
 - a. Follow manufacturer's safety recommendations for handling of chemicals.
 - b. Disconnect power to UV lights prior to sanitization.

- c. Provide controls to ensure that system remains within pre-established sanitization conditions and that system pressure does not exceed Design Conditions in Part 1.5 above.
 - d. Ensure that proper chemicals are used and that they are handled safely.
 - e. Notify personnel with access to system that sanitation is being performed. Prior to cleaning, tag each use point to indicate that valve is not to be used.
 6. Provide all equipment, fittings, and supplies necessary to execute sanitization.
 7. Prepare a procedure which identifies:
 - a. Recirculation circuits and sampling points.
 - b. Measures required to confine sanitizing solution.
 - c. Step-by-step procedure (including any modifications to piping or controls).
 - d. Sign-off matrix.
 8. Isolate equipment or instrumentation that is not to be exposed to sanitant.
 - a. Bypass ion exchange beds.
 - b. Turn off UV lights.
 - c. Record all changes made to system that are required to execute test.
 9. Record execution of procedure including Owner sign-off.
- B. Procedure for peracetic acid
1. Makeup solution of 1% Minncare with water that is less than 70°F. Water shall be equivalent to service water quality or deionized water (minimum 1 megohm) that has passed through a 1.0 micron filter. Fill entire system with solution. All gas must be vented, and system set up for recirculation so that all parts will be exposed to solution.
 2. Recirculate at flow rate of at least 3 fps. Draw samples at points of use and at other key sample points to confirm presence and concentration of peracetic acid solution using test strips. Monitor system temperature to ensure that it does not rise above 75°F.
 3. Confirm that there is solution throughout system, and then continue to recirculate for at least 3 h. Draw off water for at least one minute at each use point.
 4. After recirculation with peracetic acid solution flush system with product quality water for at least 45 minutes, rotating draw off from all use points.
 5. Test water with peracetic acid solution residual test strips at key sample points to ensure less than 1 ppm is achieved.
 6. Continue to flush for 30 minutes. Draw off water for at least 1 minute at each use point.
 7. Return system to its original configuration. Verify that all modifications that were made to piping or controls were restored. Prepare system for normal operation.

END OF SECTION

**SECTION 22 6720.13
HIGH PURITY WATER SYSTEM**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies the system for production and distribution of Deionized Water (DI).

1.02 SCOPE

- A. Contractor's Scope of Work includes:
1. Subcontracting with an acceptable water treatment equipment vendor (Vendor) and managing Vendor's scope of work and performance. Coordinating:
 - a. Size of equipment and skids with delivery schedule to ensure that equipment can be moved into place.
 - b. A drawing showing layout of equipment positioned in Owner's area.
 - c. Identification of all field installation of piping and wiring interconnections required between Vendor's equipment.
 2. Installation of Vendor's equipment and providing utilities to equipment.
 - a. Providing piping and wiring interconnections between Vendor equipment as required.
 3. Providing distribution piping.
 4. Coordination of startup and system Turnover with Owner to ensure system is always actively managed.
- B. Vendor's Scope of Work includes furnishing:
1. A complete system, as defined in this document.
 2. Detailed drawings and instructions to Contractor for installation for field piping and wiring interconnections required between Vendor's equipment and components.
 3. Documentation
 4. Sanitization of system
 5. On-site support checkout, startup, and testing
 6. Demonstration that system meets quality and operational requirements
 7. On-site training
 8. Operation of system until turnover to Owner

1.03 RELATED WORK

- A. HPW system shall meet requirements of following Sections:
1. Section 20 0513 - Motors
 2. Section 20 0529 - Mechanical Supporting Devices
 3. Section 20 0553 - Mechanical Systems Identification
 4. Section 20 0573 - Mechanical Systems Firestopping
 5. Section 22 6714.13 - Plastic Piping for High Purity Service

1.04 BASIS OF DESIGN

- A. Vendor is responsible for providing system that consistently and reliably delivers water of the following quality to the supply of distribution loop piping.
1. If Vendor believes that system design specified herein will not meet the quality standards, Vendor shall notify Engineer.
- B. Water Quality Requirements
1. System shall provide water meeting specifications of American Society of Testing and Materials (ASTM) Type II Reagent Grade Water per ASTM D1193. Specification is:
 - a. Conductivity: ≤ 1.0 micro siemens/cm (25°C)
 - b. Resistivity: ≥ 1.0 megohms - cm (25°C)
 - c. pH: NA
 - d. TOC: ≤ 50 micrograms/liter

- e. Sodium: ≤ 5 micrograms/liter
- f. Chlorides: ≤ 5 micrograms/liter
- g. Total silica: ≤ 3 micrograms/liter
- h. Microbial Level: none

C. Supply Water Quality

1. Vendor is responsibility for confirming validity of supply water analysis and notifying Engineer if quality is significantly different than stated below.
2. Minimum temperature of supply water: 60°F
3. Minimum pressure of supply water: 50 psig
4. Maximum pressure of supply water: 80 psig

D. Capacity Requirements

1. System shall produce [XXX] gpm of water of quality stated above.
2. Individual equipment shall comply with capacity and efficiency requirements stated below.

E. Size Requirements

1. Equipment shall be located in area shown on drawings referenced in Part 1.1. Location and sizes of equipment shown in those areas are preliminary.
2. Contractor shall work with Vendor to determine equipment layout and submit an accurate drawing indicating positions of equipment in the area.
3. Layout shall ensure:
 - a. Selected equipment and skid sizes will be able to pass through available building opening and passageways, or must be delivered prior to completion of that area of building.
 - b. Proper access to HPW equipment and instrumentation for operations and maintenance.
 - c. Compatibility with floor drains shown on drawings.
 - d. Clearance for removal of regularly replaced components (filter elements, UV lamps, etc.)
 - e. Access to tank manway and components on top of tank.

1.05 DOCUMENTATION

- A. The following documents shall be furnished as follows:

	Submit For Approval	Upon Delivery	Turn Over Package
Production flow rates; flows to drain	X		
Piping and Instrumentation Diagram (P&ID)	X	X	As built
Pump Curves with Operating Points	X		X
Utility Loads	X		X
Drawing of system in facility space	X		
Instructions for Rigging, Storage, and Anchoring		X	
Instructions for extended storage of system, if necessary		X	
Detailed Equipment drawings	X	X	X

	Submit For Approval	Upon Delivery	Turn Over Package
Equipment List	X		X
Descriptions of equipment and components.	X		X
Instrument List	X		X
Instrument Cut sheets	X		X
I/O List	X	X	X
Calibration Certifications		X	X
Operational and control description and functions	X		
Functional Specification	X	X	As built
Loop Diagrams		X	X
Control Schematics		X	X
Control Panel wiring drawings		X	As built
Component Cut Sheets	X		X
PLC Program Printout and Disk File			As built
OIT Configuration		X	As built
Electrical single line diagrams	X	X	X
Schematic wiring diagrams		X	X
Electrical panel drawings		X	X
Sanitization Procedure	X	X	
Acceptance Test Procedures		X	
Acceptance Test Report			X
Water sampling results			X
O & M Manuals		X	As built
Training Program Outline		X	
Service Agreement Proposal		X	

1.06 WATER TREATMENT EQUIPMENT VENDORS

- A. Acceptable Vendors: Burt Process Equipment, Crossbow-Water, Evoqua Water Technologies, Stilmas Americas, Therma Corporation, US Water Services, Veolia, Wigen Water Technologies, or approved equal

1.07 DELIVERY

- A. Vendor shall provide complete instructions on handling, rigging, anchoring, and on-site reassembly with unit.
- B. Vendor is responsible for packaging to ensure unit arrives undamaged and uncontaminated.
1. Nozzles shall have covers which protect the face from damage and seal system from contamination.
 2. Parts shipped loose shall be boxed and properly identified with durable, waterproof shipping tags attached with stainless steel wire or plastic tie strips. Parts shall be match marked for easy reassembly at site.

PART 2 - PRODUCTS

2.01 GENERAL

- A. For equipment that is skid mounted:
1. Size of skid must be compatible with building dimensions and/or delivery must be coordinated with construction schedule to ensure that skid can be moved into building and set in place.
 2. Skid size and dimension must be compatible with room layout.
 3. Skids shall conform to AISC Manual of Steel Construction.
 4. Skid construction shall comply with local and state code seismic requirements.
 5. Single connection for each utility and for drain shall be provided.
 6. Frame to be stainless steel or carbon steel with 2 coats epoxy paint.
 7. Frame shall adequately support system components at their operating weights.
 8. Surfaces that allow water to pool on part of frame are not permitted.
 9. Skids shall be designed so that they may be lifted by both forklift truck and overhead crane.
 10. Vendor shall inform contractor of field work required to assemble and interconnect skids.

2.02 WATER SOFTENER

- A. Unit shall be comprised of duplex alternating, water softener tank, complete with piping, automatic brass control valves, controller, pressure gauges, sample valves, resin, gravel, outlet "Y" strainer, dry-brine tank and brine eductor. Unit shall be preassembled, prewired, and hydrostatically tested. Media shall be packaged separately.
- B. Design Criteria
1. Each tank shall be sized to handle the service flow rate with the following criteria:
 2. Volumetric Flow Rate: less than 3 gpm/ft³ at service flow rate
 3. Velocity: greater than 2.5 gpm/ft²
 4. Normal hardness leakage: Less than 1 ppm as CaCO₃
 5. Endpoint effluent hardness: Less than 5ppm as CaCO₃
 6. Back wash flow rate: 4 6 gpm/ft²
 7. Type: Resin Amberlite IR-120-Na (Rohm and Haas) or equal
 8. Regenerant Chemical: saturated NaCl
 9. Regenerant Quantity: 15 lb/ft³ maximum
 10. Regeneration Rate: 0.5 to 0.63 gpm/ft²
 11. Method of Chemical Introduction: Eductor
 12. Capacity: 30,000 grams/ft³ (as CaCO₃) at max salt dosage
- C. Mechanical
1. Softener vessel
 - a. Material: Fiberglass or epoxy coated carbon steel
 - b. Pressure Rating/Test: 100/150 psig
 - c. Temperature Rating: 120°F
 - d. ASME Code Stamped: No
 - e. Floor Support: Structural base
 - f. Piping Connections: threaded
 - g. Vessel internal distributors shall be PVC or ABS.
 - 1) Inlet Distributor (Top): Top inlet baffle
 - 2) Underdrain Distributor (Bottom): Hub radial with PVC laterals.
 - h. Access ports shall be provided in top head for control valve connection, media loading and removal.
 2. Piping: Per referenced pipe section.
 3. Y-Strainer: Bronze or PVC body with 20 mesh screen
- D. Brine Tank:
1. Description: Dry-brine system with elevated grid plate
 2. Quantity: 1
 3. Material: Polyethylene

- 4. Salt Dose: 6-15 lb/ft³ of softener resin
- E. Controls
 - 1. Motor-driven control valve shall stage each softener through regeneration steps. Regeneration shall be initiated by signal from alternator controller.
 - 2. Regeneration frequency shall be based on throughput volume, totalized at common effluent.
- F. Electrical: 120VAC, 1 Ph, 60 Hz power supply
- G. Pressure gauges shall be provided before and after unit.
- H. Sample valve shall be provided after unit.

2.03 CARBON FILTER

- A. Unit shall be comprised of a carbon filter, complete with piping, fully automatic brass motor driven multi-port control valve, pressure gauges, sample valves and media. Unit shall be preassembled, prewired, and hydrostatically tested. Media shall be packaged separately.
- B. Design Criteria
 - 1. Each bed shall be capable of handling the service flow rate with the following criteria:
 - 2. Flow Rate Criteria: less than 7 gpm/ft² at design flow rate
 - 3. Chlorine Removal: 0.0 ppm at carbon effluent
 - 4. Chloramine Removal 0.0 ppm at carbon effluent
 - 5. Clean Bed Pressure Drop: less than 5 psig at design flow rate
- C. Mechanical
 - 1. Vessel
 - a. Material: Fiberglass
 - b. Pressure Rating/test: 100/150 psig
 - c. Temperature Rating: 120°F
 - d. ASME Code Stamped: No
 - e. Internal distributors:
 - 1) Material: PVC or ABS
 - 2) Inlet Distributor (Top): Top inlet baffle
 - 3) Underdrain Distributor (Bottom): Hub radial with laterals
 - f. Access: ports in top head for control valve connection and media loading/removal.
 - 2. Media: Acid washed Activated Carbon, Fine Gravel, Medium Gravel.
 - 3. Piping:
 - a. As per referenced pipe Section.
 - b. Provide connections for sanitization.
- D. Controls: Backwash frequency controlled by seven-day time clock. Operator shall have option to select day-of-week and time-of-day for backwash to occur.
- E. Electrical: 120 VAC, single phase, 60 Hz
- F. Pressure gauges shall be provided before and after unit.
- G. Sample valve shall be provided after unit.

2.04 CARBON FILTER – SERVICE EXCHANGABLE

- A. Description: service exchangeable activated carbon cylinder.
- B. Design Flow: Refer to drawings.
- C. Design Criteria
 - 1. Flow Rate Criteria: less than 7 gpm/ft² at service flow
 - 2. Chlorine Removal: 0.0 ppm at carbon effluent
 - 3. Chloramine Removal 0.0 ppm at carbon effluent
 - 4. Clean Bed Pressure Drop: less than 5 psig at service flow rate
- D. Mechanical
 - 1. Vessel:

- a. Material: Fiberglass
 - b. Pressure rating/test: 100/150 psig
 - c. Temperature rating: 120°F
 - d. ASME Code Stamped: No
 - e. Piping Connections: Threaded
- 2. Hoses: Polypropylene
 - 3. Carbon: New virgin activated carbon
- E. Pressure gauges to be provided before and after unit. Sample valve to be provided after unit.

2.05 REVERSE OSMOSIS (RO) UNIT

- A. RO unit shall be skid mounted, fully automatic, single pass system. Unit shall be preassembled, prewired, and hydrostatically and functionally tested.
- B. Design Conditions
- 1. Design flow: Refer to drawings.
 - 2. Feedwater Temp: 60°F
- C. Design Criteria
- 1. Max Average Permeate Flux/Element: 18 gfd (Gallons/ft²/day)
 - 2. System Recovery: 75%
 - 3. Minimum Salt Rejection: 96% at stated recovery
 - 4. RO Membranes:
 - a. Type: Polyamide thin-film composite
 - b. Manufacturer: Filmtec (Dow) or approved equal
 - c. Minimum Salt Rejection: 98%
- D. Instrumentation
- 1. The following instruments shall be provided:
 - a. Flow indicator on permeate
 - b. Flow indicators on reject on reject
- E. Mechanical
- 1. Frame:
 - a. System shall be supported by epoxy-coated frame, and designed to provide easy access for servicing, maintenance, and monitoring of operation.
 - b. Piping shall be neatly arranged and supported on frame.
 - c. Frame shall be designed for seismic zone indicated in Part 1.1 and shall offer maximum support and protection for system components.
 - 2. RO Prefilter: 5 micron absolute, sized for max 3 psi pressure drop at maximum RO flow.
 - 3. Valves:
 - a. Automatic, pneumatically actuated, non-metallic, or stainless steel valve shall be provided in feed line.
 - b. High pressure valves, including pump discharge throttling valve, reject throttling needle valve and reject recycle throttling needle valve shall be 316 stainless steel.
 - c. Actuated flush valve shall be provided on a by-pass around reject throttle valve.
 - d. Sample valves shall be provided on feed, product, and reject lines. Individual sample valve on product tubing of each pressure vessel shall be provided for analyzing system performance.
 - e. Reject and reject recycle needle valves shall be mounted in close proximity to their respective flow rate indicators for ease of field adjustment.
 - 4. Pressure gauges shall be furnished to monitor RO inlet pressure, pump suction pressure, membrane feed pressure, membrane reject pressure and RO product pressure.
 - 5. Pressure Vessels:
 - a. Manufacturer: Advanced Structures, Inc. or approved equal

- b. Material: FRP
- c. Rating: 400 psig
- 6. Piping:
 - a. Piping shall be designed for minimal removal during membrane loading.
 - b. Nozzles shall be provided for connection of temporary lines for cleaning and sanitizing RO membranes and vessels.
- 7. Material and connections:
 - a. Feed and Reject Pipe: Per referenced pipe section
 - b. High Pressure Pipe: 316L stainless steel tubing
 - c. Product Piping: Per referenced pipe section
 - d. Pump: 316 stainless steel
- F. Control System: Microprocessor or PLC based control system shall monitor and control operation of system and communicate with pretreatment equipment and distribution tank level as required. Skid mounted control panel shall house control system, operator interface controls, solenoids, IEC motor starter(s), step down transformer, high voltage disconnect. Control system shall be fully programmed and integrity tested at factory prior to shipment.
 - 1. System shall provide the following functions
 - a. On start-up, inlet valve should open prior to initiation of pump to completely fill the system with water.
 - b. Upon shutdown of pump, actuated flush valve shall open for 3 minutes. After 3 minutes, flush valve and inlet valve shall close.
 - c. Provide one discrete general fault signal for use.
 - 2. Panel shall include:
 - a. Lights, pushbuttons, and switches for status and control of system
 - b. Conductivity monitor for feed and permeate
 - c. Elapsed run time indicator
 - d. Alarm horn
 - e. System power switch
 - f. Nameplates for device identification
 - g. Automatic reject flush indicator and controls
 - 3. Alarm conditions shall Include:
 - a. Low feed pressure
 - b. High and High High permeate conductivity
 - 4. Unit Shutdowns include:
 - a. Low feed pressure
 - b. Pretreatment filters in backwash
 - c. Product storage tank full
 - d. High High permeate conductivity
 - 5. Functional Specification
 - a. Complete functional specification shall be provided which describes:
 - 1) operation of unit
 - 2) control loops
 - 3) interlocks
 - 4) alarms
 - 5) startup/shutdown sequences
 - 6) security
- G. Electrical
 - 1. RO unit shall have a single connection for 480 V, 3 phase power. Transformers for devices requiring other voltage shall be provided integral to skid.

2.06 MIXED BED DI COLUMNS - EXCHANGABLE

- A. Description: Service exchange, mixed resin, ion exchange beds. Beds contain 60% anion/40% cation resin mixture, premium grade
- B. F-[XXX], CO-DI-[XXX]
 - 1. Design flow: gpm Refer to drawings.
 - 2. Design Criteria
 - a. Volumetric Flow Rate: Less than 10 gpm/ft³ at design flow
 - b. Pressure Drop: Less than 3 psi per bed at design flow
 - c. Cation Resin: Strong acid, hydrogen form
 - d. Anion Resin: Strong base type 1, hydroxyl form
 - e. Resin Capacity: 15,000 grains/ft³
 - f. Sodium Leakage: 0.1 ppm
- C. Vendor shall provide beds in configuration shown on flow diagram in sufficient number to achieve design flow and criteria.
- D. Mechanical
 - 1. Vessels: fiberglass reinforced plastic (FRP) with vinyl ester lining and connections
 - 2. Vessel Rating: 150 psig at 100°F
 - 3. Hoses: polypropylene
 - 4. Piping: as per referenced pipe Section
- E. Instrumentation
 - 1. Locate conductivity indicator after first set of beds
 - a. Setpoint 2.0 megohm
 - 2. Pressure gauges shall be provided before and after unit. Sample valve shall be provided after unit.

2.07 STORAGE TANK

- A. Description: polyethylene, cylindrical, atmospheric, closed top tank with flanged and covered manway.
- B. Acceptable Manufacturers: Chemtainer, Polyprocessing, Snyder Tanks, or approved equal
- C. Tank to be one piece, seamless construction of high density linear polyethylene.
- D. Polyethylene to be FDA approved for food contact as per 21 CFR 177.1520. Resin complies with ASTM D-1998.
- E. Design for at least 1.9 specific gravity. Temperature is 60° to 80°F.
- F. Tank shall be air-tight
- G. Cone or dish bottom shall be totally drainable.
- H. Indoor location
- I. Dished top head
- J. Epoxy coated (2 coats) steel, or plastic support, so that bottom tank nozzle is at least 18" off of floor.
- K. Nozzles:
 - 1. Nozzles shall be welded inside and outside. Nozzles shall be flanged and gasketed. Bulkhead style nozzles will be acceptable for most polyethylene tanks where the water does not have a tight bacterial limit. The bulkhead fittings are not sanitary by design. Welded nozzles should be used for water systems having a bacterial limit at or below 100 cfu/ml. The list of tank manufacturers should also be modified if welded nozzles are required as not all manufacturers will be able to supply this fitting.
 - 2. Manway shall be flanged with gasketed, bolted cover. Standard lid is unacceptable.
 - 3. Minimum size of nozzles is as per following schedule. Vendor is responsible to ensure adequate number and size of nozzles
- L. Quality Control :

1. Vendor shall have active quality control program.
2. Tank fabrication and all welds shall be inspected, and inspection shall be documented.
3. Testing shall conform to ASTM D-1998.
4. Tank shall be kept clean during and after fabrication consistent with use for high purity service.

2.08 STORAGE TANK VENT FILTER

- A. Description: Cartridge filter housing and hydrophobic sterile filter element for vent filtration.
- B. Acceptable Manufacturers: Pall, Millipore, Sartorius, or approved equal
- C. Design Conditions
1. Rating: 0.2 micron
 2. Pressure Drop: 0.2 psid maximum at 8 scfm
- D. Filter Housing:
1. Material: Polypropylene
 2. Pressure Rating: 50 psig minimum
 3. Gasket Material: Silicone
- E. Filter Element:
1. Quantity: per Vendor
 2. Grade: Pharmaceutical, 0.2 micron absolute, hydrophobic
 3. Material: PVDF/Polypropylene

PART 3 - EXECUTION

3.01 CONTRACTOR RESPONSIBILITIES

- A. Coordinate delivery of tank and skids with building construction to ensure that tank can be moved into building and set in place.
- B. Inspect delivered equipment and components for evidence of damage or contamination
- C. Rig, handle, store, set, and anchor equipment as per Vendor's recommendations and in manner that prevents impact damage and excessive stress.
- D. Maintain a high level of cleanliness during handling and installation.
1. Prior to starting work, identify areas that will be used for storage and fabrication, and take measures to prevent contamination from adjoining areas.
 2. Keep openings on assemblies sealed during fabrication to prevent contamination prior to final installation.
- E. Provide housekeeping pads as indicated on the drawings identified in Part 1.1.
1. Determine final size of pads based on approved Vendor submittal drawings.
- F. Install equipment level and plumb.
- G. Interconnect Vendor equipment as required
1. Install HPW piping in compliance with specification in "Related Work"
 2. Connect utilities.
- H. Ensure that the system is ready for safe startup.
- I. Provide tagging for equipment, piping, and valves.
- J. Coordinate startup, balancing, testing and turnover of system with Owner and Vendor.
1. Contractor shall be responsible for maintaining system in good working condition until final turn-over to Owner. Contractor may choose to actively operate system or place system in safe, non-operational state if significant time period is anticipated prior to Owner turn-over.
 - a. Contractor shall monitor system to assure all parameters are within specified ranges if system remains in operation. Contractor shall perform routine maintenance to keep system in proper operating condition.
 - b. Contractor shall be responsible for protecting system from damage or degradation if system is to be placed in non-operational state. Procedures and protective measures shall comply with manufacturer's recommendations for storage. System shall be

drained and purged/dried with nitrogen to prevent corrosion. Contractor shall identify utility and other live system connections that should be isolated and locked out. Remove and store internal elements that can degrade if system is not operational. Provide written startup procedure for restoring system to operation.

3.02 VENDOR RESPONSIBILITIES

- A. Provide a representative responsible for on-site activities:
1. Verify that system is ready for startup.
 - a. Inspect installation, interconnections, utility connections, vents, etc.
 - b. Load media and filter elements as required.
 - c. Conduct pre-startup check-out.
 2. Startup and test system.
 - a. Verify proper operation in all operating modes.
 - b. Adjust operation of equipment and controls to meet operational, water quality, and safety requirements, and update documentation as required.
 - c. Test and balance distribution system and achieve stable operation at specified flow and pressure conditions.
 - d. Adjust self contained backpressure regulator at end of distribution loop to maintain pressure at its upstream pressure gauge at the design setpoint value.
 - 1) Verify system flows are as per design values
 3. Sanitize system as per procedure.
 4. Demonstrate to the Owner or to the Commissioning Agent that system operates in accordance with requirements of this specification and per approved submittal documentation.
 - a. Provide procedures that systematically verify that system operates as designed.
 - 1) Identification of acceptable ranges for all operating parameters.
 - b. Draw samples from at least 4 locations on the distribution loop and provide the results of analysis indicating that the water meets the bacteria level requirement.
 - 1) Arrange for the bacterial analysis to be performed by an independent testing laboratory, using standard methods, compliant with the requirements of the water quality standard in Part 1.5.
 - c. Calibrate resistivity and TOC monitors and provide calibration certification.
 5. Maintain operational oversight of system until Owner's organization is able to assume responsibility for operation.
 6. Provide Turn Over documentation as identified in Part 1.
 - a. Documents shall include the final operational setpoints and information.
 7. Provide training for Owner
 - a. Provide a program that covers overview, operator training, and maintenance training.
 - b. Operations training shall include:
 - 1) Start-up procedure
 - 2) Shutdown procedure
 - 3) Emergency operations
 - 4) Safety procedures and hazards
 - 5) Alarm conditions and actions
 - 6) Parameter adjustments
 - 7) Security

END OF SECTION

**SECTION 23 0000
GENERAL HVAC REQUIREMENTS**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Specification requirements defined in Division 20 of this Specification apply to, and are in addition to the work associated with equipment, systems, materials, and installation requirements specified in Division 23. Contractor shall provide the requirements specified in Division 20 to obtain complete systems, tested, adjusted, and ready for operation.

1.02 RELATED WORK

- A. Section 20 0000 - General Mechanical Requirements
- B. Section 20 0513 - Motors
- C. Section 20 0514 - Variable Frequency Drives
- D. Section 20 0529 - Mechanical Supporting Devices
- E. Section 20 0553 - Mechanical Systems Identification
- F. Section 20 0700 - Mechanical Systems Insulation

PART 2 - PRODUCTS

2.01 NOT APPLICABLE TO THIS SECTION.

PART 3 - EXECUTION

3.01 NOT APPLICABLE TO THIS SECTION.

END OF SECTION

**SECTION 23 0550
VIBRATION ISOLATION**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 20 0529 - Mechanical Supporting Devices
- B. Section 23 2123 - Pumps
- C. Section 23 3400 - Fans
- D. Section 23 3314 - Ductwork Specialties (Duct Flexible Connections)
- E. Section 23 7214 - Heat Recovery Equipment
- F. Section 23 7323 – Factory Fabricated Custom Air Handling Units
- G. Section 23 7400 – Packaged Rooftop Air Handling Units
- H. Section 23 8126 - Split System Air Conditioners

1.02 DESIGN CRITERIA

- A. Isolate all motor driven mechanical equipment, unless otherwise noted, from building structure, and from systems that they serve, to prevent equipment vibrations from being transmitted to structure. Unless specifically indicated, follow the latest edition of ASHRAE Application Handbook - Sound and Vibration Control, or manufacturer's recommendations for isolator selection whichever is more stringent.
- B. Select and locate isolators to produce uniform loading and deflection. Use minimum of 4 isolators to support each piece of equipment.
- C. Select vibration isolation devices based on the lowest operating speed of equipment.
- D. Vibration Criteria:
 - 1. All rotating equipment shall operate at speeds less than 80% of their true critical speed. Unless otherwise required, equipment shall be balanced according to recommendations given in the following schedules.
 - 2. Vertical vibration of rotating equipment shall not be greater than levels indicated. Vibration shall be measured on equipment. If equipment has inertia base, allowable vibration level is reduced by ratio of equipment weight alone to equipment weight plus inertia base weight.
 - 3.

<u>Equipment Speed</u> rpm	<u>Maximum Allowable</u> <u>Vibration Displacement</u> Peak-to-Peak (mil)
100 to 200	10
200 to 300	6
300 to 600	4
600 to 1000	3
1000 or 2000	2
over 2000	1

- E. Following field installation, each fan and pump over 25 hp shall be balanced in accordance with the following maximum rms velocity levels:
 - 1. Fans: 0.15 inch/sec
 - 2. Pumps:
 - 0.16 inch/sec for 30 hp and smaller
 - 0.18 inch/sec for 40 through 60 hp
 - 3. Allowable field pump vibration values above are based on HI 9.6-2000, Figure 9.6.4.12.

1.03 SUBMITTALS

- A. Submit Shop Drawings including, but not limited to, the following:
 - 1. Manufacturer's name

2. Isolator type and model number
3. Materials of construction and finish
4. Dimensional data
5. Load ratings (lbs)
6. Isolator free and operating heights
7. Static deflections
8. Isolation efficiency based on lowest operating speed
9. All other appropriate data

1.04 SUPERVISION, INSPECTION AND CERTIFICATION

- A. Vibration isolation manufacturer or qualified representative shall provide supervision to assure correct installation and adjustment of isolators. Upon completion of installation and after system is put into operation, manufacturer or manufacturer's representative, shall make final inspection, adjustment, and submit report to Engineer in writing, certifying correctness of installation and compliance with Specifications.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials used shall retain their isolation characteristics for life of equipment served. Elastomeric materials shall comply with ASTM D2240 and shall be oil-resistant industrial grade neoprene.
- B. Isolators shall be treated to resist corrosion.
- C. Isolation devices subject to weather shall have either hot-dip or cold-dip galvanized, cadmium plated, or neoprene coated finish after fabrication and be furnished with limit stops to resist wind.
- D. Vibration isolator springs shall have minimum additional travel to solid equal to 50% of rated deflection.
- E. Ratio of lateral to vertical stiffness of vibration isolators shall not be less than 0.8 or greater than 2.0.
- F. Coordinate selection of devices with isolator and equipment manufacturer.

2.02 MANUFACTURERS

- A. Mason Industries, Amber/Booth Co., Aeroflex-VMC-Korfund. Vibration Eliminator, Vibro-Acoustics, or Kinetics equal to manufacturer's model listed, except flexible pipe connections.
- B. Mason, Metraflex, Proco, Twin City Hose, Engineered Flexible Products (EFP) or Flex-Weld/Keflex for flexible pipe connections.

2.03 TYPE 1 MOUNTS (NEOPRENE PAD)

- A. Mason Type Super W, neoprene waffle pads, 50 durometer. Select number and size of pads as required to accept equipment operating weight evenly.

2.04 TYPE 2 MOUNTS (NEOPRENE MOUNTS)

- A. Mason Type ND or rails Type DNR, double deflection neoprene mounts with cast-in metal inserts for bolting to equipment.
- B. Both surfaces shall be rib molded for skid resistance. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above mountings to compensate for overhang.

2.05 TYPE 3 MOUNTS (UNHOUSED SPRING WITH NEOPRENE)

- A. Mason Type SLF, combination spring and neoprene with rib molded base. Spring type isolators shall be free standing and laterally stable without any housing and complete with 1/4" neoprene acoustical friction pads between baseplate and support.
- B. Mountings shall have leveling bolts rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of compressed height of spring at rated load.

2.06 TYPE 4 MOUNTS (RESTRAINED SPRING WITH NEOPRENE)

- A. Mason Type SLR, combination spring and neoprene with rib molded base similar to Type 3 above but shall have housing that includes vertical limit stops to prevent spring extension when weight is removed.
- B. Installed and operating heights shall be the same. Maintain minimum clearance of 1/2" around restraining bolts and between housing and spring so as not to interfere with spring action. Limit stops shall be out of contact during normal operations. Use height saving brackets.

2.07 TYPE S BASES (STEEL BASE)

- A. Mason Type WF, structural steel bases, rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases which may be "T" or "L" shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells. Perimeter members shall be beams with minimum depth equal to 1/10 of longest base span between isolators, but not less than 4". Beam depth need not exceed 14" provided that deflection and misalignment is kept within acceptable limits as determined by manufacturer. Employ height saving brackets in all mounting locations to provide base clearance of at least 1" above floor or housekeeping pad.

2.08 TYPE I BASES (INERTIA BASE)

- A. Mason Type K, or BMK rectangular or T shaped structural beam or channel concrete forms for floating foundations. Bases for split case pumps shall be large enough to provide support for suction and discharge base ells. Base depth need not exceed 12" unless specifically recommended by base manufacturer for mass, rigidity or component alignment. Base depth shall be a minimum of 1/10 of longest base span between isolators, but not less than 6". Forms shall include concrete reinforcement bars welded in place running both ways. Furnish forms with drilled steel members with sleeves welded below holes to receive equipment anchor bolts where anchor bolts fall in concrete locations. Employ height saving brackets in all mounting locations to maintain base clearance of at least 1" above floor or housekeeping pad.

2.09 TYPE 5 HANGERS (SPRING HANGER WITH NEOPRENE)

- A. Mason Type 30N, vibration hangers with steel spring and neoprene element in series. Neoprene element shall be molded with rod isolation bushing that passes through hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through 30° arc before contacting hole and short circuiting spring.
- B. Mason Type DNHS may be used where load rating and specified deflection cannot be accommodated by Type 30N.

2.010 TYPE 6 HANGERS (PRECOMPRESSED SPRING HANGER WITH NEOPRENE)

- A. Mason Type PC30N, vibration hangers similar to Type 5, but precompressed to rated deflection so as to keep piping or equipment at fixed elevation during installation. Design hangers with release mechanism to free spring after installation complete and hanger is subjected to its full load.

2.011 TYPE T THRUST RESTRAINTS

- A. Mason Type WB, horizontal thrust restraint consisting of spring element in series with neoprene pad as described for Type 3 mounts with the same deflection as specified for mountings or hangers. Spring element shall be contained within steel frame and designed so it can be preset for thrust at factory and adjusted in field for maximum of 1/4" movement at start and stop. Furnish thrust restraints complete with rods and angle brackets for attachment to both equipment and ductwork or equipment and structure. Attach horizontal restraints at centerline of thrust and symmetrically on either side of unit.

2.012 FLEXIBLE PIPING CONNECTORS

- A. Flexible connectors shall be suitable for pressure, temperature and fluid involved, but not less than 215 psig working pressure at 250°F for 14" and smaller and 150 psi working pressure at 250°F for 16" and larger.

- B. Flexible connectors shall be straight pipe configuration and shall not be used to replace pipe fittings such as elbows.
- C. Where metal braided covered flexible connector is utilized, minimum live length of flexible connector shall be as follows.

Nominal Pipe Diameter (mm(in))	Minimum Live Length (mm(in))
65 mm(2-1/2") and smaller	300 mm(12")
80 mm(3") and 100 mm(4")	460 mm(18")
130 mm(5") and larger	600 mm(24")

- D. Water System:
 - 1. Connection to Rotating Equipment:
 - a. Connectors shall consist of Kevlar or Nylon tire cord fabric reinforced with EPDM cover and liner. Solid steel rings or steel wire shall be used within raised face rubber flanged ends to prevent pullout. Furnish connectors with control rods only where recommended by connector manufacturer.
 - b. 50 mm(2") and Smaller: Threaded connections, single sphere design similar to Mason SAFEFLEX SFU.
 - c. 65 mm(2-1/2") and Larger: Floating steel flange connections, two sphere design with ductile iron or plated carbon steel reinforcing rings, similar to Mason SAFEFLEX SFDEJ. Single sphere design similar to Mason SAFEFLEX SFEJ, may be used for 350 mm(14") and larger.
 - 2. Connection to Non-rotating Equipment Mounted on Vibration Isolators:
 - d. Seamless corrugated bronze or stainless steel flexible connector with braided cover for 50 mm(2") and smaller with threaded or flanged connections; seamless corrugated stainless steel flexible connector with braided cover for 65 mm(2-1/2") and larger with flanged connections.
- E. Refrigerant System:
 - 1. Seamless corrugated bronze flexible connector with bronze wire braided cover and standard copper tube ends for copper piping. Seamless corrugated stainless steel flexible connector with braided cover for steel piping.
- F. Compressed Air Systems:
 - 1. Seamless corrugated bronze flexible connector with bronze wire braided cover for copper piping and seamless corrugated stainless steel flexible connector with braided cover for steel piping. Connector ends shall be threaded, soldered, or flanged to match piping system valve ends.
- G. Do not provide flexible piping connectors for compressed air piping.
- H. Do not provide flexible piping connectors for gas piping

2.013 PERFORMANCE

- A. Select vibration isolation devices to achieve either minimum 95% isolation efficiency or minimum static deflection and mounting requirements listed below, whichever is greater. Minimum static deflections listed below are not nominal but certifiable minimums with actual installed load. Unless otherwise indicated, apply requirements listed for floor mount for roof-mounted equipment.

TYPE OF EQUIPMENT	<u>Ground</u>		<u>Floor Span</u>							
	<u>Supported Slab</u>		<u>Up to 20 ft</u>		<u>20 ft to 30 ft</u>		<u>30 ft to 40 ft</u>		<u>40 ft to 50 ft</u>	
	Type	Min Defl. (in)	Type	Min Defl. (in)	Type	Min Defl. (in)	Type	Min Defl. (in)	Type	Min Defl. (in)
<hr/>										

Pumps:

Flexible Coupled (End suction and double suction/split case)

Thru 40 hp	Bolt to pad	3-I	0.75	3-I	1.5	3-I	1.5	3-I	2.5
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Inline Support inline pumps by connected pipes if suspended or by pipe stands or support frame from floor as shown. No vibration isolation mounts are required. Provided spring hangers for connected piping as specified in this Section.

Air Compressors:

Tank Mounted Horizontal

Thru 10 hp	3	0.75	3	0.75	3	1.5	3	1.5	3	2.5
15 hp and over	3-I	0.75	3-I	0.75	3-I	1.5	3-I	1.5	3-I	2.5

Tank Mounted Vertical and Base Mounted

All sizes	3-I	0.75	3-I	0.75	3-I	1.5	3-I	1.5	3-I	2.5
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Vacuum Pumps:

Tank Mounted Horizontal

Thru 10 hp	3	0.75	3	0.75	3	1.5	3	1.5	3	2.5
15 hp and over	3-I	0.75	3-I	0.75	3-I	1.5	3-I	1.5	3-I	2.5

Tank Mounted Vertical and Base Mounted

All Sizes	3-I	0.75	3-I	0.75	3-I	1.5	3-I	1.5	3-I	2.5
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Centrifugal Inline Fans:

Suspended Use Type 5 hangers with deflection from blower minimum deflection guide. Use Type 5-T for over 4" static pressure.

Fan Coil Units:

Type 5 with minimum deflection of 0.5" for 600 cfm or less and 0.75" for over 600 cfm.

Piping Connected to Rotating or Recipro-Equipment:

Use flexible piping connections, and Type 6 hangers for distance of 100 pipe diameters or 50 ft away from equipment, whichever is greater. Hangers shall have minimum deflection of 0.75" for pipe sizes 3" and smaller, 1.5" for pipe sizes 4" through 6" and 2.5" for pipe sizes 8" and larger. For piping less than 2" in diameter, neoprene or felt pad inserted between pipe or pipe covering and clamp or hanger may be used in lieu of Type 6 hangers.

Where piping is floor-supported, above requirements shall apply, but use Type 3 mounts instead of hangers.

Flexible piping connection shall not be used for unit heaters and in-line pumps that are supported by connected pipes. Type 6 hangers with 1" minimum deflection shall be applied within one foot of both sides of in-line pump and for distance of 100 pipe diameters or 50 ft away from first hanger at in-line pump, whichever is greater.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install and adjust vibration isolation devices as specified, as shown on drawings and according to manufacturer's recommendations.

1. Adjust isolators after the fan system is at operating weight.
 2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
 3. Adjust active height of spring isolators.
 4. Adjust restraints to permit free movement of equipment within normal mode of operation.
 5. Adjust air-spring leveling mechanism.
- B. In no case shall installation short circuit isolation devices.

3.02 INERTIA BASES (TYPE I BASES)

- A. Provide required concrete for inertia bases. Refer to Section 20 0000 - General Mechanical Requirements for concrete work.
- B. Raise inertia bases to final elevation with temporary blocking prior to making piping connections to pumps or ductwork connections to fans. After connections are complete, install vibration isolators in accordance with manufacturer's installation instructions.

3.03 FLEXIBLE PIPING CONNECTIONS

- A. Provide flexible connections for piping connected to rotating or reciprocating equipment, equipment such as coils mounted on vibration isolators, and as indicated on plans and details.
- B. Piping connected to coil which is in assembly where fan is separately isolated by vibration isolators and duct flexible connections does not require flexible piping connectors or piping vibration hangers.
- C. Piping connected to HHW boilers shall have flexible piping connections and piping vibration hangers to prevent thermal stress in piping system.

3.04 AIR HANDLING UNITS

- A. Roof mounted air handling units with internal supply and general exhaust fans are to be provided with internal fan vibration isolation.

3.05 FLEXIBLE DUCT CONNECTIONS

- A. Provide flexible connections for duct connected to air handlers and exhaust fans; refer to Section 23 3314 - Ductwork Specialties (Duct Flexible Connections).

END OF SECTION

SECTION 23 0594
WATER SYSTEMS TEST ADJUST BALANCE

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 23 2118 - Valves
- B. Section 23 2120 - Piping Specialties
- C. Section 23 2123 – Pumps
- D. Section 23 5214 – Primary Heating Equipment

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 DESCRIPTION

- A. TAB Contractor shall be responsible for providing complete testing, adjusting and balancing (TAB) work for HVAC hydronic systems, such as pumps, boilers, coils and other processes included in this project.
- B. Work required shall consist of setting volume flow rates and adjusting speed controls, recording data, making tests, and preparing reports, as specified herein.
- C. Scope of work includes TAB of new work specified herein and includes all equipment, distribution systems, and terminal units connected.
- D. Work is limited to new areas within the construction boundaries and does not include central pumping equipment or other areas. Make attempts to balance flows to values indicated. If flow is low, attempt to proportional balance flows to the same percentage below design.
- E. TAB work shall be performed by persons trained in TAB work and certified by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Procedures shall be in accordance with the latest edition of AABC, NEBB or TABB Standards, ASHRAE - 2011 HVAC Applications Chapter 38, and as detailed herein.
- F. Mechanical Contractors who are members of AABC or NEBB and who have qualified personnel available to perform work may submit Quality Assurance Submittal for approval. Mechanical Contractors who cannot meet these requirements shall subcontract with independent TAB Contractor who meets these requirements. TAB subcontractor shall prepare Quality Assurance Submittal for Contractor who will submit it for approval.
- G. Upon direction of Architect/Engineer or TAB subcontractor, Mechanical Contractor shall provide at no additional cost to Owner, any additional work and/or devices necessary to properly balance system, including calibrated balancing valves, gauge tappings, flow sensors, and thermometer wells. Mechanical Contractor shall be responsible for trimming and balancing pump impellers as necessary to obtain design pump flow rates at the minimum pressure differential.
- H. TAB work shall not proceed until all assigned personnel have been approved by Architect/Engineer via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork must be completed before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Architect/Engineer.

1.04 SUBMITTALS

- A. General:
 - 1. Make submittals in accordance with project submittal procedure. Submit minimum of 5 copies of submittals unless otherwise directed (3 for O&M Manuals, 1 for A/E, 1 for Contractor).
 - 2. Reports shall be assembled using 3-ring hard cover binder with project name and location on cover and side panel. Information sheets shall be 8-1/2" x 11" white bond paper. Use pre-printed forms of NEBB or AABC wherever possible. Provide sortable electronic version

as well as hard copy. Provide numbered tabs for each system. Assemble report in the following order:

- a. Transmittal letter
 - b. Cover sheet with project title, location, submittal date, and name and addresses of Owner, Mechanical Contractor, TAB subcontractor, Architect, and Engineer
 - c. Index of numbered tabs listing major systems
 - d. Data organized by system in the following order:
 - 1) Equipment data and measurement summary
 - 2) Equipment measurement data
 - 3) Branch main measurement data
 - 4) Terminal device measurement data arranged by room or zone
 - e. Reduced-size copies of "As-Built" Mechanical Piping drawings on 11" x 17" white bond paper
- B. Quality Assurance Submittal:
1. Within 30 days of signing contract, Contractor shall submit the following information:
 - a. Firm resume
 - 1) AABC, NEBB active membership certificate
 - 2) Names of 3 recent relevant completed projects along with project address, Owner's contact person, supervising design professional
 - b. Supervisor resume
 - c. Balance technician's resumes
 2. Architect/Engineer and/or Owner reserves the right to contact previous project representatives and to reject persons whom Architect/Engineer and/or Owner feel are not qualified for this project due to lack of relevant experience or problems on previous projects.
- C. Planning Report:
1. Submit Planning Report as detailed in Part 3 of this Section to demonstrate to Architect/Engineer and Owner that proper procedures are being followed. Submit Planning Report after Quality Assurance submittal and 30 days before any fieldwork starts.
- D. Initial Test Report:
1. Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to Architect/Engineer and Contractor incomplete work or problem areas to be resolved before final balance is completed.
- E. Final Report:
1. Within 30 days after fieldwork is completed, submit Final Report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

1.05 REFERENCE STANDARDS

- A. Refer to the latest publications of NEBB, AABC and ASHRAE publications for establishing required procedures.

PART 2 - PRODUCTS

2.01 INSTRUMENTATION

- A. Provide required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB or AABC Standards and instrument manufacturer's specifications.
- B. Instruments used for measurements shall be accurate, and calibration histories for each instrument shall be available for examination by Architect/Engineer upon request. Calibration and maintenance of all instruments to be in accordance with requirements of NEBB or AABC Standards.

PART 3 - EXECUTION

3.01 GENERAL

- A. TAB work shall be done in separate phases as outlined herein. TAB schedule shall allow ample time to complete TAB work before occupancy. Follow procedures outlined herein and as described in Planning Phase narratives.
- B. Unless otherwise specified, maximum acceptable offset tolerance shall be $\pm 10\%$ of design flow rates indicated on drawings and schedules.

3.02 PLANNING PHASE

- A. Procedure:
 - 1. Obtain the latest Contract Documents including addenda, construction bulletins and change orders. Obtain shop drawings and performance curves from Mechanical Contractor for pumps, flow measuring devices, and terminal devices. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.
- B. Planning Report:
 - 1. Planning Report shall contain the following minimum requirements.
 - 2. Narratives: Furnish written narratives of procedures to be used. Include separate narratives for each pump and liquid fluid handling system. Identify flow-measuring devices to be used at each pump and terminal device. Include different narratives for constant and variable flow systems. For non-standard water systems, include narratives on how to measure and adjust for different viscosities. Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include specified adjustment tolerances.
 - 3. Prebalance Checklist shall include, but not be limited to:
 - a. Check for completeness of work
 - b. System cleaning
 - c. System fill and air venting
 - d. Place system into operation
 - e. Check expansion tanks and fill pressures
 - f. Pump bearings, alignment, starters, vibration isolators, rotation
 - g. Setting valves to proper position including shut-off and bypass valves
 - h. Set up of controls and control devices
 - 4. Measuring Instrument List: List of measuring instruments will be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:
 - a. Manufacturer name and model number
 - b. Measurement range
 - c. Pressure/temperature limits
 - d. Date put into service
 - e. Date of last calibration
 - f. Certificate from calibration firm
 - 5. Architect/Engineer reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument that has not been recalibrated within past year.
 - 6. Samples: Submit copies of TAB forms to be used.
 - 7. Branch circuit and terminal measurements and adjustments: Indicate on pre-printed forms all measurements to be taken and adjustments to be made in field. Include branch circuit or terminal identification, system, space served, location, design flow rates (including zone and system summaries), and flow measuring device size, type, Cv, and manufacturer. Indicate the initial set points on forms.

3.03 SET-UP PHASE

- A. Procedure:
 - 1. Perform prebalance checkout as per Planning Phase narrative.
- B. Initial Test:
 - 1. Measure pump data and flow rates in "as found" condition after initial valve settings are made.
- C. Initial Test Report:
 - 1. Submit report to Architect/Engineer and Mechanical Contractor indicating measurements made and including notes of items that are not complete or are not within design tolerance.

3.04 FINAL BALANCE PHASE

- A. Procedure:
 - 1. Perform procedures as per Planning Phase narrative. Correct deficiencies and redo procedures as required prior to submitting Final Report.
 - 2. Tag full load amps/voltage on each pump motor over 1 hp after final balance is completed.
- B. Final Report:
 - 1. Submit report to Architect/Engineer and to Mechanical Contractor indicating all data, measurements and adjustments as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports.
- C. Final Report Adjustments:
 - 1. Architect/Engineer reserves the right to check any measurement or adjustment made and to reject any portion of work not within specified tolerance. Contractor shall resubmit all or portions of Final Report as directed by Architect/Engineer.

END OF SECTION

SECTION 23 0595
AIR SYSTEMS TEST ADJUST BALANCE

PART 1 - GENERAL

1.01 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.02 DESCRIPTION

- A. This Contractor shall be responsible for providing complete testing, adjusting and balancing (TAB) work of all air systems, such as air handling units, return fans, exhaust fans, air terminal devices, diffusers, grilles and other air moving processes included in this project.
- B. Work required shall consist of setting volume (flow) and speed adjusting facilities provided or specified for the systems, recording data, making tests and preparing reports, all as hereinafter specified.
- C. TAB work may be performed by Mechanical Contractors who are members of Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) and who have qualified personnel available to perform work. Mechanical Contractors who cannot meet these requirements shall subcontract with independent TAB Contractor who meets these requirements.
- D. Upon direction of Engineer, Contractor shall provide at no additional cost to Owner, any additional work and/or devices necessary to properly balance system, including fan sheave, motor sheave and/or drive belts.

1.03 SUBMITTALS

- A. General:
 - 1. Make submittals in accordance with project submittal procedure.
 - 2. Use NEBB or AABC standard forms wherever possible.
- B. Planning Report:
 - 1. Submit Planning Report as detailed in Part 3 of this Section to demonstrate to Architect/Engineer and Owner that proper procedures are being followed. Planning Report shall be submitted at least 60 days before any fieldwork starts.
- C. Initial Test Report:
 - 1. Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to Architect/Engineer and Contractor incomplete work or problem areas to be resolved before final balance is completed.
- D. Final Report:
 - 1. A preliminary Final Report shall be submitted within 30 days after completion of field work and no less than two weeks prior to Substantial Completion for review by Project Engineer of Record, and Commissioning Agent. All deficiencies noted by the TAB firm shall be listed in the preliminary report. The deficiencies deemed "minor" in nature, by the Engineer of Record, consensus shall not prevent the project from being deemed "Substantially Complete".
 - 2. All deficiencies identified in the preliminary Final Report prior to Substantial Completion shall be corrected prior to Final Completion. A Final Report, with no deficiencies, shall be submitted by the TAB firm prior to Final Completion for review and verification by the University and the Project Engineer of Record.
 - 3. Submit Final Reports as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.
 - 4. Submit Final Reports in Adobe Acrobat PDF format, consisting entirely of standard text characters compatible with the keyword search function in Adobe Acrobat. Organize Final Reports by system number and furnish table of contents and tabs for each piece of equipment or system. Each piece of equipment or system shall be represented by a

unique, specific Bookmark using the Adobe Acrobat navigation pane. Final Reports consisting of PDF pages that contain images of scanned documents are not acceptable and will be returned without review.

5. Incomplete report forms will not be approved.
6. Submit revisions to the Final Report as required to document results of Seasonal Testing.

1.04 PROCEDURES

- A. Unless otherwise specified, test, adjust and balance air systems including all equipment, apparatus and distribution systems in accordance with the latest edition of NEBB or AABC Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
- B. Seasonal Testing:
 1. Perform TAB work for each air handling unit to measure and record the performance of each system under full heating and cooling load conditions.
 2. Schedule each phase of seasonal testing based on outside air conditions:
 - a. Perform heating season TAB work when the outside air is no more than 10°F greater than the scheduled peak heating dry-bulb temperature condition.
 - b. Perform cooling season TAB work when the outside air is no lower than 5°F less than the than the scheduled peak cooling dry-bulb temperature condition.
 - c. When variations in outside air conditions do not allow for scheduled seasonal testing to be performed during the construction phase, return to the site to provide additional phases of TAB work after construction is complete to allow for seasonal testing during conditions noted herein.
 3. Seasonal Testing is only required for air handling units; air terminal, branch ducts, and outlets are not required to be included in Seasonal Testing.
- C. Additional Air Handling Unit Coil Capacity Testing:
 1. After temperature controls installation is complete, test each air handling unit coil at four different air flow settings: 25%, 50%, 75%, and 100% of full design air flow rate. Cooling coil control valve and pump system shall modulate automatically to maintain setpoints as described in control sequences.
 2. Measure and record entering/leaving water temperatures corresponding to each air flow setting to document as-installed capacity and part-load performance.

1.05 GUARANTEE

- A. Guarantee that all test-adjust and balance work, be performed in accordance with NEBB Standards and that all air systems operate within plus or minus 10% of design flow rates as shown on plans and/or as scheduled.
- B. Where supply airflow rates and exhaust airflow rates are used to maintain lab offset air directional control or room pressure relationships, maximum acceptable supply air offset shall be 0 to +10% of design flow rate. Associated exhaust air (or return air) flow rate shall be balanced to provide indicated differential between supply air and exhaust air (or return air) after supply air system has been balanced.

PART 2 - PRODUCTS

2.01 INSTRUMENTATION

- A. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB or AABC Standards and instrument manufacturer's specifications.
- B. Instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by A/E upon request. Calibration and maintenance of instruments to be in accordance with requirements of NEBB or AABC Standards.

2.02 INSTRUMENT TEST HOLE PLUGS

- A. Center-pull plugs similar to Alliance Plastics CP Series. Plug material shall be Grade 1 virgin polyethylene.

PART 3 - EXECUTION

3.01 GENERAL

- A. Test, adjust and balance all air systems and the associated components in accordance with procedures outlined in the Standards.
- B. Upon completion of TAB work, mark equipment settings, including damper control positions, fan speed control levers, and similar devices to indicate final setting in approved manner.
- C. Plug holes in insulation, ductwork and housings with acceptable test plugs.

3.02 PLANNING PHASE

- A. Procedure:
 - 1. Obtain the latest Contract Documents including addenda, applicable construction bulletins and change orders. Obtain shop drawings and performance curves from Mechanical Contractor for fans, flow measuring devices, and all terminal devices. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.
- B. Planning Report:
 - 1. Planning Report shall contain the following minimum information:
 - a. Samples: Provide copies of all forms to be used.
 - b. System narratives: Provide narratives for each air system which shall include procedures for measuring static pressures at each component of air handling system to generate a static pressure profile. Measurements shall be made to measure performance of system in all operating modes.
 - c. Air terminal narratives: Narratives shall describe procedures for measuring flows and adjusting controls to meet specified minimum and maximum flow rates based on actual field installed conditions.
 - d. Branch duct and air outlet measurements: Indicate on preprinted forms all measurements to be taken in field. Include branch duct or air outlet identification, system, space served, location, and design flow rates (include zone and system summaries). Indicate duct or air outlet neck size, make, model number, Ak factor, and design velocities.
 - 2. Prebalance Checklist - to include, but not limited to:
 - a. Check for completeness of work.
 - b. System cleaning if required.
 - c. Check fire, smoke and balancing damper positions.
 - d. Place system into normal operation without economizers.
 - e. Install test openings where required.
 - f. Indicate type of test holes to be used and installation procedure.
 - g. Note condition of filters.
 - h. Provide temporary blankoffs to simulate design pressure drops of filters.
 - i. Chisel holes and duct tape are not allowed.
 - j. Wet cooling coils.
 - k. Fan wheels, blades, bearings, alignment, starters, vibration isolators, and rotation.
 - l. Drive belt tension and alignment.
 - m. Setting of automatic dampers to proper position.
 - n. Set up of controls and control devices.
 - 3. Measuring Instrument List: List measuring instruments that will be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:
 - a. Manufacturer name and model number
 - b. Measurement range
 - c. Pressure/temperature limits
 - d. Date put into service

- e. Date of last calibration
 - f. Certificate from calibration firm
4. Architect/Engineer reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument, which has not been recalibrated within past year.

3.03 SET-UP PHASE

- A. Procedure:
 - 1. Perform prebalance checkout as per Planning Phase narrative.
- B. Initial Test:
 - 1. Measure fan and terminal data and flows in "as found" condition after initial damper settings are made.
- C. Initial Test Report:
 - 1. Submit report to Architect/Engineer and Mechanical Contractor indicating all measurements made and make notes of all items, which are not complete or are not within design tolerance.

3.04 FINAL BALANCE PHASE

- A. Procedure:
 - 1. Perform all procedures as per Planning Phase narrative. Correct all deficiencies and repeat procedures as required before submitting Final Report.
- B. Final Report:
 - 1. Submit reports indicating all data and measurements as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports.
 - 2. Assemble report in the following order:
 - a. Transmittal letter
 - b. Cover sheet with Project title, location, submittal date, and name and addresses of Owner, Mechanical Contractor, TAB subcontractor, Architect, and Engineer.
 - c. Index of numbered tabs listing all systems.
 - d. Data organized by system in the following order:
 - 1) Equipment data and measurement summary
 - 2) Equipment measurement data
 - 3) Branch main measurement data
 - 4) Terminal device measurement data arranged by room or zone
 - 3. Each individual Final Report Form submitted shall bear name of person who recorded data and seal of supervisor of TAB Contractor.
 - 4. Include identification of all types of instruments used and their last dates of calibration with Final Reports.
 - 5. Note any and all discrepancies in design flows on report forms.
- C. Final Report Adjustments:
 - 1. Architect/Engineer reserves the right to check any measurement made and to reject any portion of work not within required tolerance of design flow. TAB Contractor shall resubmit all or portions of Final Report as directed by Architect/Engineer.

END OF SECTION

**SECTION 23 0901A
CONTROL SYSTEMS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 20 0513 - Motors
- B. Section 23 0550 - Vibration Isolation
- C. Section 23 2118 - Valves
- D. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables
- E. Section 26 0533 - Raceway and Boxes for Electrical Systems
- F. Control Sequences: Refer to Drawings

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 DEFINITIONS

- A. The following abbreviations, acronyms, and definitions are used in addition to those details found elsewhere in contract documents.
 - 1. Actuator: Control device to provide motion of valve or damper in response to control signal
 - 2. AI: Analog Input
 - 3. AO: Analog Output
 - 4. Analog: Continuously variable state over stated range of values
 - 5. Auto-Tune: Software routine used to adjust tuning parameters based on historical data
 - 6. BAS: Building Automation System
 - 7. BMS: Building Management System
 - 8. DDC: Direct Digital Control
 - 9. DDCP: Direct Digital Control Panel
 - 10. Discrete: Binary or digital state
 - 11. DI: Discrete Input (Sometimes referred to as Binary Input BI)
 - 12. DO: Discrete Output (Sometimes referred to as Binary Output BO)
 - 13. EMCS: Energy Management and Control System (Typically interchangeable with BAS or BMS)
 - 14. E/P: Voltage to pneumatic transducer (Often a solenoid valve is referred to as an E/P transducer)
 - 15. FA: Field Adjustable
 - 16. FC: Fail Closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source
 - 17. FMS: Facility Management System linking two or more BAS
 - 18. FO: Fail Open position of control device or actuator. Device moves to open position on loss of control signal or energy source
 - 19. I/P: Current to pneumatic transducer
 - 20. Instrument: Device used for sensing input parameters or used for actuation
 - 21. Modulating: Movement of a control device through an entire range of values proportional to an infinitely variable input value
 - 22. Motorized: Control device with actuator
 - 23. NC: Normally Closed position of switch after control signal is removed
 - 24. NO: Normally Open position of switch after control signal is removed
 - 25. Node: DDCP, operator workstation, or other control device connected to communication's network

- 26. Operator: Same as actuator for motorized devices. Also refers to an individual who physically "operates" the facility
- 27. PC: Personal Computer
- 28. Peer-to-Peer: Mode of communication between controllers in which each device connected to network has equal status and each shares its database values with all other devices connected to network.
- 29. P: Proportional control, control mode with continuous linear relationship between observed input signal and final controlled output element.
- 30. PI: Proportional - Integral control, control mode with continuous proportional output plus additional change in output based on both amount and duration of change in controlled variable (Reset control).
- 31. PID: Proportional - Integral - Derivative control, control mode with continuous correction of final controlled output element versus input signal based on proportional error, its time history (reset), and rate at which its changing (derivative).
- 32. Point: Analog or discrete instrument with addressable database value
- 33. Self-Tune: Same as Auto-Tune
- 34. Solenoid: Electric two position actuator (See E/P)
- 35. TCC: Temperature Control Contractor (Same as Control Contractor).
- 36. TCP: Temperature Control Panel

1.04 ACCEPTABLE CONTROL CONTRACTORS

- A. Control Contractor shall have full service office within 100 miles of Project site. Full service office is defined as having complete parts inventory, having all required test and diagnostic equipment, and to be home office of Applications Engineers, Supervisors, and Field Technicians. Control Contractors shall be factory authorized agent or dealer of controllers and control hardware as manufactured by:
 - 1. Siemens Building Technologies
 - 2. Johnson Controls, Inc
 - 3. Honeywell, Inc
 - 4. Alerton Technologies
 - 5. Automated Logic Corporation
 - 6. KMC Controls

1.05 SYSTEMS DESCRIPTION

- A. System shall be electric and/or electronic.
- B. Control system shall be Direct Digital Control (DDC).
- C. Damper and valve actuators shall be electric type, unless otherwise noted.
- D. Damper and valve actuators for major equipment in mechanical rooms shall be electric type, unless otherwise noted. Actuators for all remote devices located in spaces outside of mechanical rooms shall be electronic type.
- E. Provide modular designed stand-alone DDCP capable of future BAS architecture with low/medium speed communication networks. Upgrade to full BAS architecture shall not require removal of existing DDCP, sensors, actuators, etc.
- F. Provide BAS architecture consisting of communication network, operator workstations, modular designed DDCP with all points addressable and modifiable from operator workstations or from master DDCP using laptop computer. BAS shall be fully expandable with addition of hardware and/or software. Expansion shall not require removal of existing DDCP, sensors, actuators, or communication networks.
- G. System shall support operator workstations as specified and shall be capable of additional workstations, limited only by systems maximum node capacity.

- H. System intelligence shall be such that operator workstation(s) can be used for programming controls, performing analysis on filed data, generating maintenance and operation reports and providing permanent storage for programs and data.
- I. Operator Workstations (OWS) and printers will be furnished by Owner. The existing OWS in the existing BADDL Maintenance Department is to be used.
- J. Provide hardware interface card to communicate with BAS network and all required software for each workstation, as defined in this Section, to make each PC full function workstation.
- K. Provide dial-up modem for communication between BAS and remote workstation stations via dial-up voice grade phone lines. Owner will provide a dedicated phone line for modem connection.
- L. All safety devices shall function in both auto and hand modes on starter.
- M. All safety devices shall function in both VFD and bypass starter modes.
 - 1. Dampers interlocked with fans shall operate in both VFD and bypass starter modes to prevent dead-head of fans.
 - 2. Valves interlocked with pumps shall operate in both VFD and bypass modes of operation to prevent dead-head of pump.

1.06 SCOPE OF WORK

- A. Provide all labor and materials for complete and fully functioning control systems in accordance with Contract Documents including this Section.
- B. Engineering services shall be performed by factory-trained engineers. System shall be installed either by trained mechanics directly employed by Control Contractor or by subcontractors who are under direct supervision of Control Contractor's field representative.
- C. Control Contractor shall be responsible for complete installation of all control devices, (except as noted), wiring, and pneumatic terminations at DDCP locations to accomplish control sequences specified in this project manual or on drawings. Power for field mounted devices that require 24 VAC, 60 Hz shall be powered from 120 to 24 VAC transformer panels provided by the Control Contractor. Control Contractor shall also be responsible for any additional instrumentation described in point schedules found in Contract Documents, which may not be directly related to any specified control sequences.
- D. Mechanical Contractor shall furnish and install all wells, taps, and other mechanical interfaces required for control equipment mounting into piping systems. Mechanical Contractor shall install all in-line mounted devices, such as valves, dampers, flow meters, static pressure probes, etc., furnished by Control Contractor. Control Contractor is responsible for installation of all other control devices, such as actuators, linkages, sensors, air terminal controllers, flow transducers, remote mounted control devices, control panels, control transformers, etc.
- E. Coordinate requirements above with Mechanical Engineer and Section 23 3600 – Air Terminal Devices, for required control devices. Define what is to be provided to the Air Terminal manufacturer for mounting at the factory, what the Mechanical Contractor is to install in the field and what the Control Contractor is to install in the field.
- F. All electrical work required, as integral part of work is responsibility of Control Contractor. Provide final control power connections including conduit, wire, and/or disconnect switches to all control devices from appropriate electrical distribution panels.
 - 1. Electrical Contractor will provide circuit breakers, junction boxes, and wiring required to provide electrical power to DDCP's panels.
 - 2. 120 to 24 VAC transformer panels shall be mounted adjacent to DDCP panels and powered from dedicated electrical circuit.
 - 3. Should any change in number of DDCPs or addition of other electrical equipment after contracts are awarded, Control Contractor shall immediately notify Electrical Contractor of change. Additional costs due to these changes shall be responsibility of this Contractor.

- G. Materials shall be as specified unless approved through procedures for product substitution specified in Division 01. Control Contractor shall provide components not specifically indicated or specified, but necessary to make system function within the intent of specification.
- H. All electrical products to be listed and labeled by UL and comply with NEMA Standards.
- I. Provide weather protection cover or weatherproof control devices where required for control devices located outdoors.

1.07 SUBMITTALS

- A. Shop Drawings:
 - 1. Refer to Division 01 General Requirements.
 - 2. Submit manufacturer's printed product data sheets for all control devices and all materials listed in bill of material in Control Contractor's control drawings. Organize sheets in order of model number, alphabetically, then numerically.
 - 3. Submit data concerning type of signal wiring and installation methods including raceway types and grounding methods.
 - a. Submit voltage drop calculations for all low voltage DDC circuits. Voltage drop to include number of devices and wiring run lengths, calculated voltage available at each device.
 - 4. Submit control drawings including, but not limited to, the following:
 - a. Front sheet index for projects with more than 10 control drawing sheets.
 - b. Overall system/network architecture drawings: Provide block diagram showing relationship of each controller, control panel, or other network devices relative to each other, label room location of each device, number and indicate model number of each device, indicate network types, and general cabling routing.
 - c. Control Drawings: Provide graphic representation of systems with all major inline components to properly locate all control devices. Identify controlled devices with their software designation on drawings, including unique valve and damper tag numbers.
 - d. Detailed wiring and piping diagrams show point-to-point hookup details of all transducers, relays, outputs, inputs and subsystem components. Label all pneumatic lines and control wires with field ID numbers/colors.
 - e. Bill of Materials: Identify actual product model number used for each control device for each schematic control drawing.
 - 1) Bill of material shall be included on flow diagrams for each system and on panel layouts showing panel components.
 - f. Sequence of operation: Provide written narrative describing each control sequence indicating method of control. Identify sensors, controllers, and actuators used with references to tag number of the controlled device. Include setpoints and offsets of each control loop.
 - 5. Instrumentation submittals can be submitted as a separate submittal from control shop drawings but must be submitted at the same time as control shop drawings.
 - 6. Submit valve schedules with shop drawings that indicate unique tag numbers for each device, equipment or system served, device model numbers, sizes, shutoff head required, actuator air pressure or force required to meet shutoff head, torque requirements for rotary valves, flow coefficients (Cv) for 10% and 100% valve stem travel, actual flow requirements based on equipment shop drawings, calculation of actual pressure drops, actuator model number, actuator torque capacities and pilot positioner locations.
 - 7. Valve and damper shop drawing submittals will not be processed unless all supporting data and sizing calculations are included.
 - 8. Submit damper schedules with shop drawings that indicate unique tag numbers for each device, equipment or system served, device model numbers, duct sizes, damper sizes, flow rates, pressure differentials, calculation of actual damper pressure drops, approach

velocities, leakage rates, torque requirements, actuator model number, actuator torque capacities and pilot positioner locations.

9. Select dampers to meet their intended service with respect to maximum approach velocities and maximum pressure differential. Damper materials shall match duct construction materials in which they are installed (galvanized steel, aluminum, 304 or 316 stainless steel, etc.).
 10. Aluminum dampers may be used in galvanized ductwork.
- B. Thermostat/Room Sensor Schedules:
1. Submit thermostat/room sensor schedule with shop drawings. Thermostat/room sensor schedule shall have detailed listing of which type is used for each room including data concerning service and model numbers, sizes, cover types, and engineering data sheets for each control device.
- C. Operation and Maintenance Manuals:
1. Refer to Division 01 - General Requirements.
 2. Operation and maintenance manuals shall provide descriptions of maintenance on all system components, including sensors and controlled devices. These shall include inspection requirements, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components, calibration instructions, parts lists, and name, address, and phone number of manufacturers' representative.
- D. Software Manual:
1. As part of operation and maintenance manuals, submit one software manual per workstation plus one extra copy for archive use. Software manuals shall be divided into separate parts with tabs for each part.
 2. Software Manual parts shall include:
 - a. Complete description of operating system including all commands, configuration programs, printouts, logs, database functions and passwords. Describe general operating procedures, starting with system overview and proceeding to detailed description of each software command feature with sample printed displays and system function description for each option. Include instructions on verifying errors, status, changing passwords and initiating or disabling control programs.
 - b. Complete description of programming language including all commands, configuration programs, control loop functions and testing. Describe general programming procedures, starting with system overview and proceeding to detailed description of each software command feature. Include instructions on creating or modifying any control algorithm or parameter, debugging, etc. This shall include all control functions, algorithms, mathematic equations, variables, setpoints, time periods, messages, and other information necessary to load, alter, test and execute custom or pre-written programs.
 - c. Software Backup: Upon successful completion of acceptance testing, submit to Owner 2 archive copies of all accepted versions of source code and compiled code for all application programs and data files, on CD ROM backup disks. All control software must be readily accessible by Owner using BAS workstation hardware and software.
- E. Record Drawings:
1. Refer to Division 01 - General Requirements.
 2. Submit revised Shop Drawings indicating all changes made during project.

1.08 VALVE SELECTION AND SIZING

- A. General:
1. Select control valves to meet their intended service without cavitation. Provide cavitation calculations for modulating globe control valves over 250°F and all modulating butterfly valves over 60°F.

2. Select control valves and actuators for 100% shut-off against system maximum differential pressure.
 3. Valve body ratings indicated in Part 2 are minimum required. Valve body, trim and packing selected shall be designed to withstand maximum pressure and temperature encountered in the systems.
 4. Submit engineering calculations for sizing modulating control valves unless valves are scheduled. Control valves serving terminal devices may be sized based on flow ranges for each pump system.
 5. Shut-off and two-position valves shall be full pipe size.
 6. Calculations for sizing modulating valves shall be based on actual characteristics of equipment and system being installed. Valve calculations shall include information such as pump head or available pressure; branch piping circuit losses including all pipe, fittings, valves, and coils; flow rates; and pressure losses of other in-line devices.
 7. Control Contractor is responsible for obtaining adequate system information necessary for sizing.
- B. Instrumentation Shut-off Valves:
1. Unless otherwise noted, instrumentation shut-off valves for isolation of gauges, switches, transmitters, etc., shall be as follows:
 - a. Compressed air/instrumentation air systems: ball or plug-type valves
 - b. Water systems: globe-type valves
 - c. Steam and condensate systems: gate-type valves
 - d. Ductwork, air handling unit or air terminal device penetrations: ball or plug-type valves
 - e. Liquid line sampling valves: multiple turn, metering-type valves
- C. Water Valves:
1. Design criteria for sizing modulating valves shall be based on two port, normally open, equal percentage valves unless otherwise specified. Heating control valves shall be globe type and shall be selected for a minimum of 25% of equipment subcircuit pressure drop, but not more than maximum available pump head allowing minimum 2 psi drop for balance valve. Cooling control valves may be globe or butterfly type and shall be selected for minimum of 10% of equipment subcircuit pressure drop, but not more than maximum available pump head allowing minimum 2 psi drop for balance valve.
 2. Select control valves based on pressure drop calculations based on Cv values at 100% stroke.
 3. Available subcircuit pump heads are as follows:

<u>Pump System</u>	<u>Available Subcircuit Head</u>
P- [XXX]	[XXX] feet

4. Subcircuit is defined as all of branch supply and return piping to terminal device, including all valve, coil, control valves, and balance valve. Size 3-way mixing or diverting valves not directly associated with pump subcircuit for 3-5 psi pressure drop.

1.09 DAMPER SELECTION AND SIZING

- A. Submit Engineering calculations for sizing modulating control dampers including outside, return, and relief air dampers of air handling units unless dampers are scheduled.
- B. Calculations for sizing dampers shall be based on actual characteristics of ductwork system being installed. Opposed blade dampers shall be sized for minimum of 10% of duct system pressure drop. Parallel blade dampers shall be sized for minimum of 30% of duct system pressure drop. Duct section is defined as ductwork containing flow control damper starting with inlet or branch tee and ending with outlet or branch tee. Calculate actual duct pressure drops for each duct section containing modulating damper using latest version of ASHRAE Handbook

of Fundamentals. If control systems fixes pressure drop, use those pressure setpoints. Use balance damper to provide additional pressure drop as required to obtain linear damper response.

- C. Control Contractor is responsible for obtaining adequate system information necessary for sizing.
- D. Provide dampers as shown on drawings or as scheduled.
- E. Two position dampers shall be sized as close as possible to duct size, but in no case is damper size to be less than duct area.
- F. Submit leakage and flow characteristics data for all control dampers along with shop drawings. Leakage ratings to be based on AMCA Standard 500 and dampers to bear AMCA Air Leakage Seals.

1.010 FCC COMPLIANCE

- A. All digital equipment furnished under this contract shall have been tested and made to comply with limits for Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against interference when operated in commercial environment. All literature shall so note and all equipment shall be so labeled to show this compliance.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Pressure and temperature ratings of devices indicated in Part 2 are minimum required. All devices shall be designed to withstand maximum pressure and temperature encountered in the system.

2.02 CONTROL WIRING

- A. Control wiring shall be in accordance with National Electric Code and local electrical codes. Final connection points at devices and panels shall be made at terminal blocks either integral to device or separate terminal blocks mounted inside of control panel enclosures. Use of wire nuts and crimped connections are not allowed for terminating control wiring unless approved by Engineer.
- B. Refer to Division 26 for specification requirements for conduits and conductors, except as noted.
- C. Signal and Power Conductors (24 V and Under):
 - 1. No wire smaller than #18 AWG shall be used, except for manufacturer supplied instrument specific wire, or unless otherwise specified. Use 2 wire stranded twisted/shielded pair 24 VDC for analog and/or discrete input and 24 VAC/VDC output devices. For RTD signal wiring, use #18 AWG stranded, tinned copper twisted/shielded three lead conductors.
 - 2. Conductors not concealed in raceway shall have UL listed plenum rated teflon insulation.
 - 3. Communication Cable: Use control system manufacturer's standard communications cable or #22 to #24 AWG twisted, shielded pairs, coaxial cable, or fiber optics for communications between remote control panels/devices. Provide 250 ohm, 5 watt, 0.1% tolerance dropping resistors in 4 – 20 mA circuits as required to generate 1 to 5 V signals in 24 VDC powered instrument loops. Provide isolated instrument grounding system per manufacturer's recommendations.
 - 4. 24 VAC Power Conductors shall be #18 AWG, 2-wire twisted pair or larger. Provide Metal Oxide Varistors (MOVs) on 24 VAC/VDC discrete outputs connected to inductive loads to reduce noise levels (i.e., solenoid valves, motor contactors, relays, damper/valve electric actuators, etc.).
 - 5. Stranded twisted/shielded control conductors are required with the shields to be terminated within variable frequency Drive enclosures to reduce the effects of noise from VFD. Follow VFD manufacturer's installation instructions for wiring control conductors to VFD.

2.03 AIR PIPING

- A. Plastic Tubing:
 - 1. Fire resistant virgin polyethylene, meeting stress-crack test ASTM D1693-60T. Individual tube polyethylene or multi-tube instrument tubing bundle shall be classified as flame retardant under UL 94. Polyethylene material shall be rated as self-extinguishing when tested in accordance with ASTM D 635.
- B. Isolation valves for air piping to be threaded or soldered, two piece, bronze ball valves as per Section 23 2118 – Valves, suitable for intended service and pressure.

2.04 LOCAL CONTROL PANELS

- A. Local control panels shall be constructed of steel or extruded aluminum with hinged door and keyed lock, with baked enamel finish of manufacturer's standard color. Construction shall comply with NEMA 1 Standards for interior panels, NEMA 4 for exterior panels.
- B. Controlling instruments, temperature indicators, relays, switches and gauges shall be factory installed and permanently labeled. Devices shall be located inside or mounted on face of panel.
- C. Unless otherwise indicated, mount control and adjusting switches, temperature indicators and other indicating or manually operated devices on front face of panel with black phenolic engraved nameplates.

2.05 DIRECT DIGITAL CONTROL PANEL (DDCP)

- A. General:
 - 1. Direct Digital Control Panels (DDCP) shall be microprocessor based, field programmable controllers, capable of performing control and energy management functions, and shall be UL Listed as Signaling Systems. Each DDCP shall include its own microprocessor, power supply, input/output modules, and termination modules as required to perform its intended function.
 - 2. DDCP shall receive discrete electrical or analog electronic field input signals, convert signals for use by controller, perform control sequences, convert controller information into output signals, and provide control output signals to actuators and field control device. All inputs and outputs, including communication connections, shall be electrically or optically isolated from controller.
 - 3. DDCP with analog input modules shall be capable of accepting any form of linear or non-linear voltage (0-5 VDC or 0-10 VDC), current (4-20 mA) or resistive input (0-1000 ohm).
 - 4. DDCP with discrete input modules shall be capable of accepting discrete inputs from any device with isolated, dry-type contacts (no grounds or no voltage) of either normally open (NO) or normally closed (NC) configuration. Provide visible status lights (LEDs) to indicate input point status.
 - 5. Provide input modules capable of interfacing with pulsed output type sensors as required.
 - 6. DDCP with discrete output modules shall have isolated, dry-type contacts (no grounds or no voltage) of either normally open (NO) or normally closed (N.C.) configuration.
 - 7. Provide manual H-O-A override switch for each discrete output point. Provide feedback point to BAS to indicate when output point has been overridden. Provide visible status lights (LEDs) to indicate output point status.
 - 8. DDCP shall have capability to scale, offset, and display proper analog value without field hardware modification. DDCP shall convert analog input signals to digital values (A/D conversion) and convert digital values to analog outputs (D/A conversion) for modulating control purposes.
 - 9. Failsafe hardware shall be provided such that BAS failures result in immediate return to local control. If DDCP uses database values from other DDCP and communication network fails or malfunctions, control loop outputs shall continue to function using last value received from BAS.
 - 10. DDCP shall have ability to interface and communicate with central BAS through a dedicated network. DDCP shall be fully operable from and have all points and functions

available to centrally alarm at any master DDCP or PC workstation connected to BAS network.

B. DDCP Operator's Interface:

1. Provide communications port to connect display device for operator access to all information and all operating system functions except database reports and graphics functions in each mechanical room.
2. Display keyboards to be alphanumeric with special dedicated keys for functions such as manual-auto, test, function, value, and enter.
3. Keyboard/display units shall be able to display analog variables, binary conditions, point values and condition, and other information required for analysis and adjustment.
4. Provide minimum of one permanent panel mounted keyboard and display for each mechanical equipment room. If manufacturer does not offer dedicated panel mounted keyboard and display unit, provide portable hand held keyboard and display unit. If manufacturer does not offer dedicated hand held keyboard and display unit, provide battery powered portable PC unit with proper software and hardware to interface with local DDCP.

2.06 DIRECT DIGITAL CONTROL SOFTWARE

- A. DDCP control strategies shall be Owner definable from operator terminals or workstations.
- B. Software functions and algorithms shall be sufficient to enable implementation of control sequences as specified and able to maintain continuous control as intended.
- C. Control functions shall include both mathematical and logical operators. Control algorithms shall include proportional, integral and derivative control (PID). Adaptive (self-tuning) PID loop parameters, if offered by DDCP manufacturer, shall not be used unless adaptive limits are used to adjust limit values based on system status; or written request is submitted and approved by Engineer.
- D. Allow operator to assign unique identifiers of their choice to each connected point. Identifiers must have at least 8 alpha/numeric characters. All reference to these points in programs, reports and command messages shall be by these identifiers.
- E. Provide access control (user defined passwords) for system operation. There shall be minimum of 3 access levels. First level shall allow system monitoring only. Second level shall allow monitoring and setpoint, and scheduling revision. Third level shall allow modification of control algorithms. System shall return to secured (monitoring only) mode after 5 minutes of inactive operation.
- F. Each DDCP shall contain self-diagnostics that continuously monitor proper operation of panel.
- G. If microprocessor malfunctions, control loop outputs shall continue to function using last value received from microprocessor.

2.07 OPERATOR'S WORKSTATION HARDWARE

- A. The existing Operator Workstation that is located in the existing BADDL Maintenance Department shall communicate with BAS for the existing BAS and the expanded BAS included in this project scope on as-needed basis such that other executable programs may be processed without affecting control functions of BAS.

2.08 NETWORK HARDWARE

- A. Provide network interface hardware for each device connected to network. Each device shall have sufficient performance as not to degrade processing speed specified.
- B. Provide network cabling with sufficient performance as not to degrade communication speed specified. Cabling shall be compatible with proposed system.
- C. Provide other network support devices that are required for proper operation of network, such as file servers, signal repeaters, network hubs, etc.

2.09 CONTROL VALVES

- A. General:
 1. If control valves are not scheduled, refer to Part 1 of this Section for sizing criteria.

2. Use 2 or 3 port normally open globe type control valves with equal percentage contoured throttling plugs for water applications and linear contoured throttling plugs for steam applications, unless otherwise noted.
 3. Butterfly valves may be used for water system control valves 130 mm(5") and larger provided that valves meet pressure and temperature requirements. High performance butterfly valves shall be used for modulating applications. General-purpose butterfly valves may be used for two-position control.
- B. Globe Valves:
1. Valves shall be bronze or brass body, threaded, 1035 kPa(150 psi) rating for 50 mm(2") and smaller, iron body bronze mounted, flanged, 860 kPa(125 psig) rating for 65 mm(2-1/2") and larger.
 2. Valves shall have stainless steel stems, spring-loaded Teflon packing, replaceable seats and discs.
- C. General Purpose Butterfly Valves:
1. Refer to Section 23 2118 – Valves. Refer to Damper and Valve Actuators in this Section for valve actuators.
- D. Solenoid Valves:
1. Brass or bronze body. Valves shall be selected to match required temperatures and pressure, and shall have materials, that are compatible with, intended working fluid.
 2. All line voltage actuators shall be Class "H" (high temperature) and listed by UL or CSA.

2.010 CONTROL DAMPERS

- A. General:
1. If control damper sizes are not shown or scheduled, refer to Part 1 of this Section for sizing criteria.
 2. Unless otherwise indicated, modulating control dampers shall be opposed blade or parallel blade type and two position (open/close) dampers shall be parallel blade type.
 3. All blade linkage hardware shall have corrosion-resistant finish and be readily accessible for maintenance.
- B. Standard Modulating and Two Position Dampers:
1. Damper frames shall be minimum of 16 ga galvanized steel or 14 ga extruded aluminum. Blades shall be minimum of 16 ga galvanized steel or 14 ga aluminum. Blades shall have maximum blade width of 8" with steel trunnions mounted in bronze sleeve, nylon or ball bearings.
 2. Furnish dampers with blade seal and stainless steel side seals. Dampers and seals shall be suitable for maximum system temperature, pressure differential and approach velocity, but not less than temperature range of -40 to 200°F, pressure differential of 6" WG, and approach velocity of 4000 fpm.
 3. Dampers when closed shall be guaranteed by control manufacturer not to leak air in excess of 100 cfm at 4" WG static pressure for 48" x 48" damper size (6.25 cfm per ft²).
- C. Standard Modulating and Two Position Dampers:
1. Damper frames shall be minimum of 16 ga galvanized steel or 14 ga extruded aluminum. Blades shall be minimum of 16 ga galvanized steel or 14 ga aluminum. Blades shall have maximum blade width of 8" with steel trunnions mounted in bronze sleeve, nylon or ball bearings.
 2. Furnish dampers with blade seal and side seals. Dampers and seals shall be suitable for maximum temperature, pressure differential and approach velocity to be encountered in the system, but not less than temperature range of -40 to 200°F, pressure differential of 4" WG, and approach velocity of 2500 fpm.
 3. Dampers when closed shall be guaranteed by control manufacturer not to leak air in excess of 176 cfm at 4" WG static pressure for 48" x 48" damper size (11 cfm per ft²).
- D. Smoke Dampers:

1. Dampers to be leakage rated at no higher than Leakage Class I (4 cfm/ft² at 1" WG and 8 cfm/ft² at 4" WG) under UL 555S at temperature category 250°F. Furnish dampers with factory-mounted, caulked sleeve and pneumatic operator. Damper shall have 16ga frame with air foil-shaped blades, rated to minimum 4" WG in closed position and to 2000 fpm in open position.
2. Pneumatic actuator to be installed outside airstream, linked to damper for fail (normally) closed operation, suitable for use on 20-psig air system, and be UL Listed and labeled for application. Actuator to be capable of closing damper at pressures encountered in system.
3. Size smoke dampers as close as possible to duct size, but in no case is damper size to be less than duct size.

2.011 DAMPER AND VALVE ACTUATORS

A. Analog Electronic:

1. Actuators shall be hydraulic or electric motor/gear drives that respond proportionally to analog voltage or current input. Stroke time for major equipment shall be 90 seconds or less for 90° rotation. Stroke time for terminal equipment shall be compatible with its associated local controller, but no more than 6 minutes.
2. Provide spring return feature for fail open or closed positions as required by control sequence for critical applications such as outside, return, or exhaust dampers, heating and cooling coils on major air handling units, humidifiers, heat exchangers, and flow control for major equipment items such as chillers, cooling towers, boilers, etc.
3. Provide position feedback potentiometers connected to controller for closed loop control on major equipment analog control loops.
4. Actuators for terminal heating/cooling equipment do not require spring return feature.

B. Discrete Two-Position Electric:

1. Actuators shall be hydraulic or electric motor/gear drives for two-position control. Stroke time shall be 90 seconds or less for 90° rotation.
2. Provide spring return feature for fail open or closed positions as required by control sequence.

2.012 GENERAL INSTRUMENTATION

A. General:

1. No devices containing mercury will be allowed under this specification.

B. Pressure Gauges:

1. Refer to Section 23 2120 - Piping Specialties.

C. Thermometers (Dial-Type):

1. Refer to Section 23 2120 – Piping Specialties.

D. Analog Electronic Instrument Indicators:

1. Electronic indicators, used for displaying sensor and/or output values as measured by current or voltage, shall be panel mount type and at least 2" square. Output may be analog needle type or digital with 1/2" high LED or backlit LCD displays.
2. Electronic indicators shall be marked in appropriate units (Degrees, psi, %RH, gpm, cfm, etc.) and with appropriate range of values. Panel mounted indicators shall have minimum accuracy of 1% of scale range. Digital units shall be scaled to show 3 digits plus 1 decimal point.

2.013 DISCRETE ELECTRIC INSTRUMENTATION

A. General:

1. Electrical devices, switches, and relays shall be UL listed and of type meeting current and voltage characteristics of the project. Terminal connections shall be made at terminal blocks inside of NEMA 1 enclosures unless otherwise specified. Outdoor units shall be NEMA 4 with concealed adjustment.

2. Ratings of normally open and closed contacts shall be adequate for applied load (Minimum 5 amps at 240 V).
 3. Accuracy of devices shall be $\pm 1\%$ of scale with adjustable offset unless otherwise specified.
- B. Temperature Switches (Electric Thermostats):
1. Line voltage or low voltage type suitable for application with adjustable setpoint and setpoint indication.
 2. Low voltage type to have heat anticipation.
 3. Thermostats with remote sensing bulb shall have liquid filled sensing element and exposed setpoint adjustment.
 4. Wall mounted space thermostat enclosure shall have concealed sensing element and exposed setpoint adjustment.
 5. Unless otherwise stated, space thermostat covers shall be brushed aluminum or brushed nickel.
 6. Manufacturer's standard plastic covers may be used in lieu of metal covers.
- C. Temperature Low Limit Switches (Freezestats):
1. Electric 2-position type with temperature sensing element and manual reset. Controls shall be capable of opening circuit if any one-foot length of sensing element is subject to temperature below setting.
 2. Sensing element shall not be less than one lineal foot per square foot of coil surface areas. Unless otherwise indicated, calibrate temperature switch setpoint to 38°F.
- D. Relays:
1. Equal to IDEC type RH2B-U, miniature 8 blade pilot relay with DPDT silver cadmium oxide contacts rated at 15A, 30 VDC, or 120 VAC. Coil shall match control circuit characteristics. DDC outputs shall be 24 VDC with maximum current burden of 50 milliamps. Rectangular base socket mount with blade type plug-in terminals and polycarbonate dust cover.
 2. Provide DIN rail mountable (Snap type) mounting sockets equal to IDEC SH2B-05.
- E. Pressure Differential Switches:
1. Adjustable set point, differential pressure type. Select switches for accuracy, ranges (20 to 80% of operating range) and dead-band to match process conditions, electrical requirements and to implement intended functions.
 2. Pressure differential switches for air systems shall have pressure rating of at least 10" WG.
 3. Pressure indicating differential switches for air systems shall be equal to Dwyer Series 3000 photohelic gauge.
 4. Pressure differential switches for water systems shall be rated for 1035 kPa(150 psig) unless otherwise noted. Chilled water pressure differential switches shall be provided with totally sealed vapor tight switch enclosure on 300 psi body. Differential pressure switches to have 3-valve manifold for servicing.
 - a. Max Temperature Rating: 300°F
 - b. Repeatability: $\pm 1\%$
- F. Gas Detection Systems:
1. Manufacturers: Toxalert, OI Analytical, MDA Scientific, MSA
 2. Provide gas detection systems as listed below. Each system shall be complete package with remote or local space sensors, detection instruments, alarm contacts, local indication of current measured value for each sensor, and status indicator lights for power and status of each sensor. Devices not requiring remote mounting shall be housed in metal control panel. All status indicators shall be mounted on panel faceplate.
 3. Units shall have adjustable setpoints and self-test diagnostics.
 - a. Tag number AIT-[XXX]
 - b. Panel Location [XXX]
 - c. Gas to be Detected [XXX]

- d. Alarm Setpoint: [XXX]
- e. Range: 0-2 times Alarm Setpoint
- f. Remote Sensor Locations: [XXX]
- 4. Provide panel mounted alarm horn with silence switch.
- G. Position Switches (End Switches):
 - 1. Provide damper position switches, as required to meet specified sequence. Rotary switches shall be cam action, lever, or proximity type. Provide damper brackets and connecting rods for connecting position switch actuation levers to damper blades or jackshafts.
 - 2. "Tip Switches" or other position switches that contain mercury shall not be used for damper and valve end switch applications.
- H. Current Switches - Constant Load, Constant Speed:
 - 1. Manufacturers: Veris Industries, N-K Technologies, Absolute Process Instruments, Kele & Associates, R-K Electronics or approved equal
 - 2. These shall be induction type sensors clamped over single-phase conductor of AC electrical power and shall be solid-state sensors with adjustable threshold and normally open contacts. Each current switch shall be selected for proper operating range of current.
 - a. Output: Solid state relay or relay contacts
 - b. Trip Setpoint: Adjustable by multi-turn potentiometer
 - c. Operating Temperature: 0 to 55°C (32 to 131°F)
 - d. Response Time: < 0.5 second
- I. Current Switches - Variable Load, Variable Speed
 - 1. Manufacturers: Veris Industries, N-K Technologies or approved equal
 - 2. These shall be induction type sensors clamped over single-phase conductor of AC electrical power and shall consist of solid-state sensors with self-calibrating threshold and normally open contacts. Each current switch shall be selected for proper operating range of current.
 - a. Output: Solid state relay or relay contacts
 - b. Trip Setpoint: Self-calibrating through microprocessor
 - c. Operating Temperature: 0 to 55°C (32 to 131°F)
 - d. Response Time: < 0.5 seconds
- J. Mechanical Room and Local Control Panel Alarm Horns:
 - 1. 24V alarm horn suitable for panel mounting.
- K. Indicator Lights:
 - 1. 1/4" minimum size. Use green for normal, yellow for warning (low/high values), and red for alarm or fail (low-low or high-high conditions). AC or DC type with voltage matched to control circuit without transformers.

2.014 PNEUMATIC INSTRUMENTATION

- A. Fan Inlet Airflow Traverse Probe:
 - 1. Air Monitor Corporation, Tek-Air, Ultratech or approved equal.
 - 2. These shall be averaging differential pressure type flow elements mounted in inlet cone of fan capable of continuously measuring air volume of fan.
 - 3. Inlet flow element shall consist of:
 - a. Sensing tube with two internal chambers. One shall sense upstream pressure (velocity pressure) and one shall sense downstream pressure (static pressure).
 - b. These chambers shall have ports of quantity and size to accurately sense flow rate in fan inlet size into which these are specified to be installed.
 - c. Sensing tube shall have form so shaped as to minimize measurement inaccuracies.
 - 4. Sensing assemblies shall be provided with suitable supports to prevent damage to these assemblies at maximum flow-rate.
 - a. Accuracy: Error < ± 3.0% of actual flow

- b. Materials: Standard extruded aluminum with anodized finish. Optional 316 stainless steel, PVC, Kynar and other materials.
 - c. Mounting Hardware: Galvanized Steel
 - d. Approved Fan Inlet Installations: Centrifugal Fan
Plug Fan
Ducted Vane Axial Fan
Vane Axial Fan with Bellmouth
- B. Single-Probe Air System Static Sensing Elements:
- 1. Sensors to be similar to Dwyer Model A-301 or Tek-Air Model T-SPP7620, with angled tips and 1/4" metal tubing connections.
- C. Differential Air Pressure Indicator:
- 1. Dwyer model 2000 Series magnehelic gauge for surface or panel mounting. Four inch dial readout, die cast aluminum housing. Case and aluminum parts Iridite-dipped. Exterior finish to be baked dark grey hammerloid. Hi/lo 1/8" pressure taps. Provide adapters to match tubing type.
 - a. Accuracy: $\pm 2\%$ of full scale.
 - b. Ambient Temperature Range: 20 to 140°F.
 - c. Rated Total Pressure: -20" Hg to 15 psig.
 - d. Range: 0-2 times normal setpoint. (Use 0-0.25" WG for building and space pressure indication.)

2.015 ANALOG ELECTRONIC INSTRUMENTATION

- A. Space Temperature Sensors:
- 1. Sensors shall be nickel or platinum RTD type, with the following minimum performance:
 - a. Temperature Coefficient of Resistivity (TCR): .00385 ohm/ohm/°C
 - b. Accuracy: $\pm (0.30^{\circ}\text{C}(.54^{\circ}\text{F}) + (0.005 \times T))$ (Class B)
 - c. Accuracy: $\pm (0.15^{\circ}\text{C}(.27^{\circ}\text{F}) + (0.005 \times T))$ (Class A)
T = Temperature of interest
 - d. Conformance: DIN-IEC 751
 - e. Operating Range: -50 to 500°F
0 to 99% rh
 - 2. Thermistors or nickel RTD's will be acceptable in lieu of platinum RTD provided thermistor carries 5 year guarantee that device will maintain its accuracy within tolerance of $\pm 0.36^{\circ}\text{F}$ between 32°F and 150°F, and 0.5°F between -20°F and 212°F.
 - 3. Unless otherwise stated, space sensor cover shall be brushed aluminum or brushed nickel.
 - 4. Manufacturer's standard plastic covers may be used in lieu of metal covers.
 - 5. Provide visible setpoint, setpoint adjustment, and space temperature indication.
- B. Duct Mounted or Insertion Temperature Sensors:
- 1. Nickel or platinum RTD type, with the following minimum performance:
 - a. Temperature Coefficient: .00385 ohm/ohm/°C
 - b. Accuracy: $\pm (0.30^{\circ}\text{C}(.54^{\circ}\text{F}) + (0.005 \times T))$ (Class B)
 - c. Accuracy: $\pm (0.15^{\circ}\text{C}(.27^{\circ}\text{F}) + (0.005 \times T))$ (Class A)
T = Temperature of interest
 - d. Conformance: DIN-IEC 751
 - e. Operating Range: -50 to 170°F
0 to 99% rh
 - 2. Install insertion sensors in stainless steel probes or wells.
 - 3. Outside air sensors shall be weatherproof of noncorrosive construction and protected with solar shield. Mount outside air sensors on north side of building or in area intake wells for air handling systems to avoid thermal effects from direct sunlight.

4. Sensors mounted in air streams, such as air handling units, supply ducts, exhaust ducts or return ducts, shall be averaging type. Mount averaging sensor across duct area in a "Z" pattern using mounting clips specific for averaging temperature sensor probes.
 5. Thermistors or nickel RTD will be acceptable in lieu of platinum RTD provided thermistor carries 5 year guarantee that the device will maintain its accuracy within a tolerance of $\pm 0.36^{\circ}\text{F}$ between 32°F and 150°F , and 0.5°F between -20°F and 212°F .
- C. Space Humidity Sensors/Transmitters:
1. General Eastern, Automation Components Inc., Veris Industries, Minco (Kele & Associates, Rotronic or Vaisala).
 2. Space humidity sensors shall be wall mount type with brushed aluminum or brushed nickel cover to match room thermostats and/or temperature sensors.
 3. Sensing element shall be resistive bulk polymer, or thin film capacitive type. Sensor/transmitter shall have the following minimum performance.
 - a. Accuracy: $\pm 2\%$ rh at 25°C over 20-95% rh including hysteresis, linearity and repeatability
 - b. Temperature Effect: Less than 0.06% per $^{\circ}\text{F}$
 - c. Sensitivity: 0.1% rh
 - d. Repeatability: 0.5% rh
 - e. Hysteresis: Less than 1%
 - f. Long Term Stability: Less than 1% rh drift per year
 - g. Adjustment: $\pm 20\%$ rh zero, non-interactive
 $\pm 10\%$ rh span, non-interactive
 - h. Operating Range: 0-99% rh, non-condensing, sensor
0-95% rh, non-condensing, electronics
 - i. Output: 4-20 mA, 0-100% linear, proportional
 - j. Power: 12-36 VDC
- D. Duct Mounted Humidity Sensors/Transmitters:
1. Manufacturers: General Eastern, Automation Components Inc., Veris Industries, Minco (Kele & Associates), Rotronic or Vaisala
 2. Probe type, temperature compensated, resistive bulk polymer or thin film capacitive type. Sensor/transmitter shall have the following minimum performance.
 - a. Accuracy: $\pm 2\%$ rh at 25°C over 20-95% rh including hysteresis, linearity and repeatability
 - b. Temperature Effect: Less than 0.06% per $^{\circ}\text{F}$
 - c. Sensitivity: 0.1% rh
 - d. Repeatability: 0.5% rh
 - e. Hysteresis: Less than 1%
 - f. Long Term Stability: Less than 1% drift per year
 - g. Adjustment: 20% rh zero, non-interactive
 10% rh span, non-interactive
 - h. Operating Range: 0-99% rh, non-condensing, sensor
0-95% rh, non-condensing, electronics
 - i. Output: 4-20 mA, 0-100% linear, proportional
 - j. Power: 12-36 VDC
- E. Ducted Air System Static Pressure and Differential Pressure (Velocity) Transmitters:
1. Manufacturers: GE Modus, Setra, Ashcroft XLDP or approved equal
 2. Provide transducers/transmitters to convert velocity pressure differential or static duct pressure relative to sensor location into electronic signal.
 3. Unit shall be capable of transmitting linear 4 to 20 mA DC output signal proportional to the differential (total minus static or static minus ambient) pressure input signals with the following minimum performance and application criteria:

- a. Span: Not greater than twice duct static or velocity pressure at maximum flow rate, nor more than 16 times velocity pressure at minimum flow rate.
 - b. Accuracy: $\pm 1.0\%$ of span or $\square 1.0\%$ of full scale
 - c. Dead Band: Less than 0.5% of output
 - d. Hysteresis: Within 0.5% of span or within 0.5% of full scale
 - e. Linearity: Within 1.0% of span or within 0.5% of full scale
 - f. Repeatability: Within 0.5% of output
 - g. Response: Less than 1 second for full span input
4. Return and exhaust air system static pressure transducers/transmitters shall be furnished with protective integral air filters on pressure sensing lines from the static pressure sensing stations, and static air probes to prevent migration of moisture or particulate matter into transducers. If inputs to pressure transducers/transmitters are dead-ended, integral air filters are not required. Supply air system sensors do not require integral air filters.
- F. Insertion Type Turbine Flowmeter/Transmitter:
- 1. Manufacturers: Onicon, EMCO, FTI Flow Technology, or approved equal
 - 2. Provide turbine type flowmeter with hot tap type insertion assembly and microprocessor based transmitter. Selected span shall be not greater than twice design flow range. Select units for 10:1 turndown.
 - 3. Hot tap assembly shall be insertion/extraction type with depth gauge and shutoff valve. Select turbine and body for intended service and pressure/temperature range. Transmitter shall have linear output of 4- 20 mA with nominal 24 VDC power requirement. Enclosure shall be NEMA 4.
 - a. Accuracy: $\pm 0.5\%$ in linear range
 - b. Repeatability: 0.25% in linear range
 - c. Construction Materials:
 - 1) Non-wetted Parts: Aluminum
 - 2) Wetted Parts: 316 Stainless Steel
 - 3) Turbine: 17-4 pH Stainless Steel with tungsten carbide bearings
 - 4. Transmitter shall be integral mounted on flow meter.
 - 5. Provide remote mounted indicator/transmitter. Indicator shall be $\frac{1}{2}$ " LCD or back lit LED type.
 - 6. Refer to Section 25 3003 - Process Instrumentation Device Specifications.
- G. Electronic Controllers:
- 1. Provide dedicated function type controllers with electronic analog and/or discrete electric type inputs and electronic analog and/or discrete electric type outputs, capable of performing sequences specified. Analog loop controllers shall have PID programs. Units shall have face-plate with adjustable setpoints, calibration, offset, gain factors, and visual display of all parameters.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install control equipment, wiring and air piping in neat and workmanlike manner to satisfaction of Architect and/or Engineer, and in accordance with manufacturer's recommendations. Maintain clearances, straight length distances, etc. required for proper operation of each device. Mark and detail exact location of inline devices, wells, and taps to be installed by Mechanical Contractor on Coordination Drawings.
- B. Coordinate timely delivery of materials and supervise activities of other trade contractors to install inline devices such as immersion wells, pressure tappings, any associated shut-off valves, flow switches, level switches, flow meters, air flow stations, and other such items furnished by Control Contractor that are to be installed by Mechanical Contractor.
- C. Install control devices in accessible location.

- D. Mount motor control devices within 5 ft of disconnect switch, or starting device furnished by Electrical Contractor unless noted otherwise. Maintain required NEC clearances.

3.02 CONTROL WIRING

- A. Provide all electrical wiring required for complete functional control systems, including power circuit to control panels, both line and low voltage, in accordance with all applicable local codes, and the latest version of National Electric Code and NFPA when applicable.
 - 1. Voltage drops for all low voltage circuits shall be calculated prior to installing low voltage circuits. Voltage drop calculations shall be made available to Engineer on demand.
- B. Control panels serving equipment fed by emergency power shall also be served by emergency power. Equipment fed by emergency power is so indicated on mechanical equipment schedules and electrical motor schedules.
- C. Control panels shall be powered by local UPS (Uninterruptible Power Supply) to ensure continued control of equipment powered by site standby power sources when primary power source is lost. Devices such as Operator Workstations, Floor Level and Building Level Controllers and other critical devices shall be provided with UPS power.
- D. Power wiring to control compressors and dryers will be provided by Electrical Contractor. Provide field mounted starters to Electrical Contractor for installation and supervise installation.
- E. Install control wiring in raceway system per Division 26 - Electrical, unless otherwise noted.
- F. BAS Network Communication Cable:
 - 1. Run communication cable in separate raceways or in cable trays with proper clearances.
 - 2. Install special cable connectors in accordance with manufacturer's recommendations.
 - 3. BAS network communication cable shall not be spliced.

3.03 AIR PIPING

- A. Conceal all piping except piping in mechanical rooms and other areas where mechanical system piping is exposed.
- B. Install exposed piping and conduit parallel to or at right angles to building structure and support adequately at uniform intervals.
 - 1. Use only tool made bends.
 - 2. Provide tubing clamps with insulated standoffs where metallic tubing may come into contact with other dissimilar metals to prevent galvanic corrosion from occurring. Use of wire ties or hose clamps to fasten tubing to structure or other piping is not allowed.
 - 3. Use of tubing channel designed for mounting metallic or polyethylene tubing shall be allowed.
- C. Polyethylene tubing not exceeding 18" exposed may be used for connection to instrument or actuator.
- D. Install polyethylene tubing with no concealed splices and number code all tubing.
- E. Make tests on sectional piping during progress of installation to ensure no leakage..
- F. Piping type shall be as follows:
 - 1. Inside Panels:
 - a. Use polyethylene tubing.

3.04 LOCAL CONTROL PANELS

- A. Provide local control panel for each system where more than one control device requires field mounting (air handling units, exhaust fans, miscellaneous control systems including pump controls, heat exchanger controls, etc.). Single devices may be exposed mounted on piping, wall or ductwork. Install local control panel where indicated on drawings or suitable location adjacent to system served.
- B. Mount panel on wall with suitable brackets or on self-supporting stand. Mount top of panel no higher than 6 ft above floor. Install panels so front cover door can swing full open without interference.

- C. Label all local control panels with its respective unique ID number per Section 20 0553 - Mechanical Systems Identification.

3.05 ADJUSTMENT AND COMPLETION CHECK LIST

- A. After completion of installation, follow check standard list procedures defined by instrument vendors to adjust and calibrate all thermostats, control valves, control actuators, controllers, sensors, and other equipment provided in this Contract.

3.06 OWNER TRAINING

- A. Provide minimum of 8 hrs of on-site training to Owner's representatives. Conduct training sessions during normal business hours after system start-up and acceptance by Owner. Scheduling of training session(s) will be established by Owner.

3.07 OVERALL BAS ARCHITECTURE

- A. Provide hardware/software to update database in less than 1 second for fast-acting control loops such as pressure control, air or water volume control, and air handling unit temperature control, or 10 seconds or less for all other control loops.
- B. Control loop software algorithm for each analog control loop shall reside on the same controller as all inputs and outputs required for that specific control loop.
- C. Networks that operate via polled response or other types of protocols that rely on central processors, file servers, or other such devices to maintain or manage peer-to-peer communications shall have redundant components to maintain network in the event of failure at central device. Provide automatic changeover to redundant device upon failure of any central type processor without operator intervention.
- D. Network shall be multi-drop digital transmission network. Network shall provide communication link between operator's workstation and all remote DDCP and field panels.
- E. Each multi-drop trunk shall be within manufacturer's allowable line lengths without signal degradation. All multi-drop trunks shall be interfaced to system via standard EIA or other industry recognized interfaces so that single failure does not disrupt or halt network.
- F. Communications between DDCP's and operator's workstations shall allow multiple users to access and use system simultaneously with no loss of system performance.
- G. Provide levels of connected networks to connect all DDCP, including terminal DDCP. Communications to terminal devices shall be similar to capabilities and functions of other DDCP and shall be transparent to operator.
- H. Number of nodes (devices connected) on any one network shall not exceed 50 % of maximum node capacity published by equipment manufacturer. Provide additional hardware, DDCP, network controllers, etc.) to meet this requirement.
- I. Alarm reports from DDCP shall not be impeded by use of either remote or local monitor, nor control stations on network either in access mode or programming mode.
- J. Provide telephone modem for remote access to system from remote operator's workstation. Coordinate telephone communications with Owner for modem connection point.

3.08 DIRECT DIGITAL CONTROL PANELS

- A. DDC Panel Usage:
 - 1. Select DDCP to provide speed of response required for each control loop type.
 - 2. Each DDCP shall have sufficient I/O capacity to perform specified control sequences and/or included points listed in any point schedules. If DDCP does not have sufficient capacity, provide additional panels to achieve required point count.
 - 3. Analog and critical safety discrete control loops shall have inputs and outputs into/from the same DDCP. Analog control loops for major equipment (chilled water, hot water, convertors, air handling units, etc.) shall have PID control.
 - 4. For valves and dampers within 100 ft of its DDCP, mount current to pneumatic (I/P's) convertors within DDCP or in adjacent panel. Otherwise mount I/P convertors at valve or damper. Provide pressure gauges on main air, and all control output signals.

- B. Cabinets:
 - 1. Provide local control cabinets for all DDCP. DDCP cabinets may be used directly if enclosures are rated for NEMA 1. All cabinets shall utilize one masterkey. Provide 2 spare key sets to Owner.

3.09 SOFTWARE

- A. Software from panels shall be permanently stored on CD ROM.
- B. Provide the latest version of all standard software, including, operating system and control software. Include any software updates for period of 1 yr coinciding with warranty period. No beta released software shall be used.

3.010 INITIAL PROGRAMMING

- A. Control Contractor shall provide initial programming of all controllers to accomplish sequences specified.
- B. Provide back-up documentation per software manual submittals for all programs in both written and magnetic media formats.
- C. Provide programming of menus to assist new users in accessing screen displays of each point group. Point groups (user definable) shall be initially arranged by DDCP for major equipment and by floor and area for terminal devices. Terminal devices shall also be grouped by air handling system where applicable.
- D. Program historical file for run-times and number of start/stops of all motor driven equipment and filters.
- E. Program maintenance alarms based on run-times and number of start/stops for all motor driven equipment.
- F. Program alarms using the following levels:
 - 1. Level 1 - Maintenance alarm, requiring attention within one to 2 days. (Examples; 2-3°F temperature variance from setpoint, 15-25% relative humidity variance, etc.)
 - 2. Level 2 - Low Level Alarm, requiring attention within 8 hours, preferably during the same shift. (Examples; 4°F or more variance from setpoint, 30% relative humidity or more variance from setpoints, etc., excess start/stops per day, etc.)
 - 3. Level 3 - Critical Alarm, requiring immediate attention. (Examples; non-operation of primary equipment, H-O-A overrides.)
 - 4. Level 1 and 2 alarms shall not interrupt current user operation, but shall be logged into alarm summary file indicating status, acknowledgment, and by whom. Level 3 alarms shall interrupt user via audible and/or flashing warning until acknowledged without losing any work in progress. When alarms are acknowledged, the program shall display point group or appropriate graphic display. Level 3 alarms shall also be logged into alarm summary file similar to Level 1 and 2 alarms.

3.011 POINT LIST

- A. Provide all points required to implement control sequences specified, whether or not they are listed in schedules. In addition to control points, provide additional monitoring points listed in point schedules or defined in Control Sequences.
- B. All outputs, whether sequenced or not, shall have separate programmable hardware outputs. For air handling units, minimum outside air, maximum (economizer) outside air, return, relief air, smoke dampers, heating coil valves, cooling coil valves, humidifier valves, etc., shall each have separate output.

3.012 CONTROL VALVES

- A. Furnish control valves as shown on drawings and/or as required to perform control sequence specified.
- B. Control valves furnished by Control Contractor will be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

- C. Increaser and decreaser fittings required to facilitate valves will be provided by, Mechanical Contractor.

3.013 CONTROL DAMPERS

- A. Furnish control dampers as shown on drawings and/or as required to perform control sequence specified except those furnished with other equipment.
- B. Control dampers furnished by Control Contractor will be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.
- C. Blank-off plates or transitions required to facilitate dampers will be provided by Mechanical Contractor.

3.014 ACTUATORS AND PILOT POSITIONERS

- A. Provide actuator for each automatic damper or valve with sufficient capacity to operate damper or valve under all conditions. Select actuators to provide tight shut off against maximum system temperatures and pressure encountered. Each actuator shall be full-proportioning or two-position type as required or specified, and shall be provided with spring-return for fail open or fail closed position for fire, freeze, occupant safety, equipment protection, moisture, heating or cooling protection on power interruption as indicated and/or as required. Smoke dampers and steam valves serving pressure rated heat exchangers or convertors shall fail closed.
- B. Where sequencing of valves or dampers is required for pneumatic systems, such sequencing shall be accomplished by spring ranges adequate for applications to avoid overlap of operation and simultaneous use of heating and cooling.
- C. Provide pilot positioners for pneumatic modulating valves and dampers for major equipment such as air handling unit coils, humidifiers, heat exchangers, convertors, major water system temperature controls, etc. Pilot positioners are not required for terminal heating/cooling equipment or booster humidifiers.
- D. Provide pilot positioners for all sequenced devices, and devices that require adjustable operating speeds.
- E. Provide pilot positioners for pneumatic modulating outside and return air dampers and fan volume control devices such as fan inlet dampers where used.
- F. Provide pilot positioners for pneumatic modulating valve and damper operators when torque required by controlled devices exceeds 50% of torque capacity of operator.
- G. Valve and damper operating speeds shall be selected or adjusted so operators will remain in step with controller without hunting regardless of load variations. Operators acting in sequence with other operators shall have adjustment of control sequence as required by operating characteristics of system.
- H. Provide speed control valves for On/Off actuators for adjustment of actuator speed to prevent water hammer or excessive stress on large valves and dampers.
- I. Provide proper linkage and brackets for mounting and attaching actuators to devices. Design mounting and/or support to provide no more than 5% hysteresis in either direction (actual movement of valve stem/damper shaft/ideal movement) due to deflection of actuator mounting.
- J. Calibrate position feedback potentiometers where specified, with range and gain factors as required for proper operation per manufacturer's recommendations.
- K. Integral actuator end switches or feedback potentiometers shall not be used. Provide separate end switches/feedback potentiometers that provide actual damper/valve position.
 - 1. Integral actuator end switches or feedback potentiometers can be used if damper or valve shaft is keyed or directly affixed to the actuator such that the shaft cannot slip and provide false position. U-clamp type actuator mounting always requires separate end switches/feedback potentiometers.

3.015 GENERAL INSTRUMENTATION

- A. Pressure Gauges (Pressure Indicators):

1. Install pressure gauge for indication of supply and control pressure in pneumatic systems at output of controllers, I/P transducers, electric air solenoid valves and pressure switches, and other points where visible indication of air pressure is required for operation and maintenance purposes.
 2. Provide test port for quick connection of test gauges at valve, damper motor and other actuator branch lines.
 3. Pressure gauge tappings in piping will be installed by Mechanical Contractor.
- B. Thermometers (Temperature Indicators):
1. Install thermometers at each point of temperature transmission and control except those indicated at local control panels. Install thermometers to permit easy reading from floor or operating platform (within 3 ft of line of sight). Provide remote bulb thermometers with readout indicators mounted within 3 ft of line of sight whenever sensing point is more than 3 ft from line of sight.
 2. Thermometer wells in piping will be installed by Mechanical Contractor.

3.016 LOCAL CONTROL PANELS

- A. Install remote mounted devices, controllers, I/O terminal blocks, power supplies, etc. inside of local control panels.
- B. Locate panels as shown on drawings.
- C. Locate panels adjacent to equipment served with a minimum of 3 ft clearance in front of the door. Provide sufficient clearances to allow full door swing and full access to all internal components. Submit proposed panel locations with shop drawings.
- D. Mount top of panel between 5 and 6 ft above floor so gauges and indicators are at eye level.
- E. General Instrumentation at Local Control Panels:
 1. Provide record control drawings of systems served by each local panel, in location adjacent to or inside of panel cover. Provide protective cover for drawing.
 2. Provide indications and adjustments at each panel as follows:

Point	Item
1	Chilled water in degrees F
2	Chilled water out degrees F
3	Hot water in degrees F
4	Hot water out degrees F
5	Discharge temperature degrees F
6	Mixed air temperature, degrees F
7	Return air temperature, degrees F
8	Return air relative humidity %
9	Outdoor temperature, degrees F
10	Filter pressure drop, inches WC (Provide static pressure sensor across filter banks.)
11	Supply duct static pressure, inches WC for system air volume control.

Station Description

- Key: a = Adjustment
i = Indication
b = Adjustment and indication

3. Adjustment and indication shall be on front panels.
4. Adjustment shall be concealed inside panels.
5. Indication shall be on front panels.

	<u>Point</u>										
	1	2	3	4	5	6	7	8	9	10	11
AHU-1	i	i	-	-	b	i	i	b	i	i	i
[XXX]											
[XXX]											

3.017 DISCRETE AND ANALOG INSTRUMENTATION

- A. Wall Mounted Space Sensors:
1. Install space thermostats/sensors where indicated, as required to perform specified controls, or directed to meet job site conditions.
 2. Mount thermostats/sensors 5 ft above floor unless otherwise indicated.
 3. Mount space thermostats/sensors with accessible setpoint adjustment or temperature reading (thermometer or digital temperature readout) at 4 ft above floor meeting ADA requirements.
 4. Any room thermostats/sensors mounted on exterior walls shall be mounted on thermally insulated sub-base.
 5. Relocate room thermostats/sensors if required due to draft, interferences with cabinets, chalkboards, etc., or improper sensing.
 6. Mount room thermostats/sensors in corridors, stairways and public toilets 7 ft above floor.
 7. Room thermostats/sensors in gymnasium, locker rooms, corridor, stairways, vestibules and toilets shall be aspirating type.
 8. Room thermostats/sensors in gymnasium, locker rooms and [XXX] shall be protected by heavy-duty cast and die formed guard.
- B. Low Limit Temperature Switches (Freeze Stats):
1. Install low limit controls where indicated on drawings or as specified. Unless otherwise indicated, install sensing element at downstream side of heating coils.
 2. Distribute sensing element across entire area of medium being sensed. Install controls at accessible location with suitable mounting brackets and element duct collars where required.
- C. Static Pressure and Air Flow Stations:
1. Furnish static pressure and air flow measuring stations to Mechanical Contractor for installation.
 2. Stations shall be installed in strict accordance with manufacturer's published requirements. These stations serve as primary signals for airflow control systems, therefore it shall be responsibility of Control Contractor to verify location and installation to assure that accurate primary signals are obtained.
 3. Pressure differential switches shall be piped across the device creating the differential, between fan discharge and fan suction.
- D. Building or Room Static Pressure Control System:
1. Extend 2" pipe between spaces for room pressure control, or between space and outside for building static pressure control. Mount velocity sensor in tee fitting with 1 foot of straight pipe on either side of sensor. Terminal space and points inside of sheet metal plenum shall be attached to return/exhaust grille. Terminate outside sensors on prevailing windward side of building with flapper type damper and full weather cover shroud. Construct shroud of aluminum, painted to match building exterior.
- E. Water Flow Meters and Flow Switches:
1. Install flow measuring devices with recommended straight pipe diameters upstream and downstream of elbows, tees, valves, or other fittings, that cause uneven turbulent flow conditions.
 2. If no recommendations are given, provide straight pipe equal to 10 pipe diameters upstream and 5 pipe diameters downstream of flow measuring device.

F. Sensor Wells:

1. Mount sensor wells as shown on drawings as required by other contract documents. Wells mounted in pipe 3" and larger may be installed in horizontal or vertical lines provided element is always in flow (for condensate and other gravity return lines, install in bottom of pipe). Wells mounted in pipe 2-1/2" and smaller shall be installed at elbow tee fittings with well pointed upstream. Minimum of 2" pipe size for elbow tee installation.

G. Transmitters and Indicators:

1. Locate transmitters at sensing device or within 100 ft for remote mounted transmitters. For hot systems (150°F and higher) mount electronics on side of pipe or remotely mount. For indicating type instruments, locate indicating element with 6 ft of floor with readout easily visible from floor level. Provide remote readouts if necessary.

END OF SECTION

**SECTION 23 2116
PIPE AND PIPE FITTINGS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 20 0529 - Mechanical Supporting Devices
- B. Section 23 0594 - Water Systems Test Adjust Balance
- C. Section 23 2118 - Valves
- D. Section 23 2120 - Piping Specialties
- E. Section 23 2514 - Chemical Treatment Systems (Pipe Cleaning)

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 DESCRIPTION

- A. This Section includes pipe and pipe fitting specifications and installation requirements for heating and cooling systems.
- B. Specification of an item in this or any other sections shall not relieve Contractor from providing all items, articles, materials, operations, methods, labor, equipment and incidentals necessary for a complete and functional system.
- C. Use only new material, free of defects, rust and scale, and guarantee for services intended.
- D. Use material meeting the latest revision of ASTM specifications as listed in this specification.
- E. Follow local codes if they require other types of pipe or joints.
- F. Use only long radius elbows having centerline radius of 1.5 pipe diameters unless otherwise indicated.
- G. Manufacturer, pressure class, size and heat code of each fitting and flange shall be permanently identified on its body in accordance with MSS SP-25.
- H. Where size for a pipe segment is not indicated, the pipe segment size shall be equal to the largest pipe segment to which it is connected. Transition to smaller size shall occur on the side of fitting where smaller size is indicated.
- I. Unless otherwise indicated, fittings and accessories connected to pipe shall be of the same material as the pipe.
- J. Unless otherwise indicated, construct piping for highest pressures and temperatures in respective system in accordance with the latest revision of the applicable Sections of ASME Code for pressure piping, ASME B31 including the following:
 - 1. B31.9 Building Services Piping
- K. Non-metallic piping is acceptable only for services indicated. It is not acceptable in occupied spaces and ventilation plenum spaces.

1.04 SUBMITTALS

- A. Shop Drawings for each piping system for all pipe sizes including, but not limited to, the following:
 - 1. Name of system
 - 2. Pipe; ASTM number, grade if known, type, wall thickness, material
 - 3. Fittings; ASME number, grade if known, class, type, wall thickness, material
 - 4. Joint type
 - 5. Flanges; ASTM number, grade, class, type, material
 - 6. Bolts and nuts; material
 - 7. Thread joint sealants; material
 - 8. Flange gaskets; material, rating
 - 9. Unions; ASTM number, type, material, rating
 - 10. Type of welding

11. Welding Quality Control Program
 12. Test pressure and media
 13. Pipe flushing procedures
 14. Pipe cleaning method
 15. All other appropriate data
- B. Submit pipe certification as specified under Pipe Certification in this Section.
- C. Submit required documents as specified under Pipe Welding in this Section.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Furnish pipe with plastic end-caps/plugs on each end of pipe. Maintain end-caps/plugs through shipping, storage and handling to prevent pipe-end damage and eliminate dirt and construction debris from accumulating inside of pipe.
- B. Where possible, store materials inside and protect from weather. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping.
- C. Before shipping, all carbon steel piping shall be free of rust and scale, and furnished with plastic end caps/plugs on each end of pipe.

1.06 PIPE WELDING

- A. Procedure and Welding Qualification Records:
1. Submit Welding Procedure Specifications (WPSs) and their supporting Procedure Qualification Records (PQRs) to be used on the work to Engineer for review and approval prior to performing any welding. These documents shall meet requirements of ASME B31.9.
 2. Unless otherwise indicated, welding shall be done using only the following processes:
 - a. Shielded Metal Arc Welding (SMAW), also known as "stick" welding
 - b. Gas Tungsten Arc Welding (GTAW), also known as TIG and Heliarc welding
 - c. Gas Metal Arc Welding (GMAW), also known as MIG welding
 - d. Flux-Cored Arc Welding (FCAW), a variation of GMAW
 - e. Submerged Arc Welding (SAW)
 3. Root pass must be applied by GTAW process with argon gas purge for high-pressure steam and condensate (400 psig (2758 kPa) and over) and high temperature hot water (450°F (232°C) and over) services.
 4. Root pass must be applied by only GTAW process with argon gas purge for stainless steel pipe.
 5. Unless otherwise stated, fabrication, installation, inspection, examination and testing shall be in accordance with ASME B31.9.
 6. Backing rings (chill rings) or consumable inserts are not allowed, unless specifically requested by Owner or Engineer.
- B. Quality Control Program:
1. Submit written quality control program for review and approval prior to implementing any welding on this project. Quality control program shall include the following as minimum:
 - a. Explanation of how Contractor will assure proper fitup for each weld.
 - b. Explanation of how Contractor will assure that proper welding procedure is being followed.
 - c. Credentials of personnel responsible for required weld examinations.
- C. Weld Inspection and Examination:
1. Provide examination services for all welding for this Project. Examination shall be in accordance with requirements of ASME B31.9.
 2. Periodically, as welding progresses, submit report, signed by weld examiner, indicating status of project welding quality.

3. Arrange with Owner's Inspector for observation of fitup and welding methods prior to implementing any welds, including shop welds, on this Project.
 4. In addition, Owner's Inspector will perform any additional observations deemed necessary before, during, or after fabrication to assure, to Owner's satisfaction, that proper welding is provided. Owner reserves the right to perform independent examination of welds. If Owner has any concern as a result of such examination Owner reserves the right to stop in progress welding work, without any cost to Owner, until resolution satisfactory to Owner is reached.
- D. Welder Qualifications:
1. Each welder and welding operator must qualify by passing required procedure test before performing any project welds. Submit copy of Manufacturer's Record of Welder or Welding Operator Qualification Tests (WPQS) as required by Section IX of ASME Boiler and Pressure Vessel Code for all welding procedures to be performed by welding operator.
 2. Welder qualifications must be current. If qualification test is more than 6 months old, provide record of welding continuity for each welder.
 3. Record of welding continuity is intended to show that welder has performed welding at least every 6 months since the date that welder qualification test was passed for the submitted welding procedure specification.
 4. Record of welding continuity shall include, at minimum, the following:
 - a. Welder's employer name and address
 - b. Date Welder Qualification Test was passed
 - c. Dates indicating welding continuity
 5. Welders shall be qualified as required by ASME B31.9. In addition, there shall be an independent witness of welder tests. That witness shall be representative of independent testing laboratory, Authorized (Code) Inspector, Owner's or Engineer's Inspector or consultant approved by National Certified Pipe Welding Bureau.
 6. Welder qualifications must cover all pipe sizes and wall thickness used on this project. Test segments or coupons shall be appropriately selected for qualification. Test position shall be arranged in "6G position."

1.07 PIPE CERTIFICATION

- A. Type E or S Pipe:
1. Furnish manufacturer's mill certificates (material test report) including dimensions, heat numbers, chemical analysis and tensile test results for pipe shipped to project site.

PART 2 - PRODUCTS

2.01 HEATING HOT WATER

- A. 2" and Smaller:
1. Pipe: ASTM A53, Type F, standard weight, carbon steel.
 2. Fittings: ASME B16.4, Class 125, cast iron, threaded or ASME B16.3, Class 150, malleable iron, threaded.
 3. Unions: ASME B16.39, malleable iron, Class 250. Refer to Unions and Flanges in this Section.
 4. (Alternate Pipe Type if Approved by the Owner): ASTM B88 seamless, Type L, hard temper copper tube
 5. Fittings: ASME B16.22, wrought copper solder joint
 6. Joint: ASTM B32, lead free solder, similar to Bridgit, Silvabrite, Silverflow or Canfield
 7. Unions: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper solder joint, Class 125. No unions to be used for line sizes 3/4" and smaller. Unions shall be used for line sizes over 1".
 8. Flanges: ASME B16.24, Class 150, cast copper alloy

9. Use solder joints for valves and piping specialties in copper piping
- B. 2-1/2" and Larger:
 1. Pipe: ASTM A53, Grade B, Type E or ASTM A106, Grade B, standard weight, carbon steel
 2. Fittings: ASTM A234 Grade WPB/ASME B16.9, standard weight, seamless, carbon steel weld
 3. Flanges: Class 150. Refer to Unions and Flanges in this Section

2.02 REFRIGERANT PIPING

- A. ASTM B88 Type L hard drawn copper tube, cleaned and capped in accordance with ASTM B280, and marked "ACR" with ANSI B16.22 wrought copper or forged brass solder-type fittings.

2.03 COOLING COIL CONDENSATE DRAIN

- A. Piping shall be:
 1. Pipe: ASTM B88, Type M, hard temper copper tubing
 2. Fittings: ASTM B16.22 wrought copper fittings
 3. Joint: ASTM B32, 95-5 tin-antimony solder, Bridgit or Silvabrite

2.04 BREECHING AND VENTING OF CONDENSING BOILERS

- A. Refer to section 23 5100 Smokestack, Breeching and Vent Piping

2.05 DIELECTRIC UNIONS, FLANGES AND FITTINGS

- A. Copper to Steel Pipe:
 1. Dielectric Unions: Dielectric unions are not acceptable for copper to steel pipe joints; use dielectric nipples.
 2. Dielectric Nipples:
 - a. ASTM A120/A53 electro zinc-plated steel pipe with high temperature polyolefin polymer liner, suitable for continuous use at temperatures up to 225°F (107°C) and pressures up to 300 psig (2068 kPa).
 - b. Equal to Perfection Corporation, Clearflow Dielectric Waterway Fittings.

2.06 UNIONS AND FLANGES

- A. Unions:
 1. 2" (50 mm) and Smaller: Malleable iron, ASME B16.39 with ground joint, bronze or brass to iron. Provide black malleable iron for carbon steel piping and galvanized malleable iron for galvanized steel piping. Unless otherwise specified, pressure class and joint type of union shall be equal to that specified for fittings of respective piping service. Minimum pressure class of unions shall be Class 250.
- B. Flanges:
 1. 2-1/2" and Larger: ASTM A105, ASME B16.5, hot forged steel, welding neck pattern. Slip-on pattern is not allowed. Bore dimension of welding neck flange shall match inside diameter of connected pipe.
 2. Use raised face flanges for mating with other raised face flanges with self-centering flat ring gaskets. Use flat face flanges for mating with other flat face flanges with full face gaskets.
 3. Flange pressure class indicated in respective piping service is minimum required. Mating flange pressure class shall match pressure class of connected device, such as valves and piping specialties.
- C. Flange Gaskets:
 1. Gasket material shall be asbestos free and suitable for pressures, temperatures and fluid of respective piping system. Non-metallic gaskets shall be in accordance with ASME B16.21 and ASTM F104.
 2. Service Temperature (through 249°F) – Garlock, Klingersil or J.M. Clipper, similar to Garlock 5500. Gaskets similar to Garlock Style 3000 may be used for hydronic piping. Unless otherwise indicated or recommended by manufacturer, gaskets shall be compressed inorganic

fiber with nitrile binder 1/16" thick for flanges 12" and smaller and 1/8" thick for flanges 14" and larger.

3. Service Temperature (250°F thru 800°F) - Flexitallic, Garlock, Lamos equal to Flexitallic Style CG, flexible graphite filler, 304 SS winding, carbon steel centering ring, 0.175" thickness.

D. Bolting:

1. Bolts, bolt studs, nuts and washers shall have zinc plated finish.
2. Thread shall be in accordance with ASME B1.1, Class 2A tolerance for external threads and Class 2B tolerance for internal threads. Threads shall be coarse-thread series except that alloy steel bolting 1/8" and larger in diameter shall be 8 pitch thread series.
3. Threaded rods are not allowed as fastening elements.
4. For Class 150 and Class 300 flanges not exceeding 400°F temperature, use carbon steel bolts or stud bolts conforming to ASTM A307, Grade B with nuts conforming to ASTM A194.
5. Bolts conforming to ASTM A307, Grade A may be used for piping governed by ASME B31.9

2.07 THREADED JOINT SEALANTS

- A. Paste type for brush application or cord type. Products shall be non-toxic, chemically inert, non-hardening, rated for -50°F (-46°C) to 400°F (204°C) and up to 10000 psi (68,948 kPa) (liquids) and 2600 psi (17,926 kPa) (gases), certified by UL, CSA, and NSF.
- B. Use sealant similar to Loctite Model 54531 for piping handling oil or petroleum products.

2.08 WELD BRANCH OUTLET FITTINGS (WELDOLETS, THREADOLETS AND SOCKOLETS)

- A. Weld branch outlet fittings shall conform to MSS-SP-97, ASME B16.9 for weldolets, ASME B1.20.1 for threadolets and ASME B16.11 for sockolets.
- B. Materials shall match material of header piping and wall thickness of outlet or branch end shall match wall thickness of branch pipe.

PART 3 - EXECUTION

3.01 GENERAL

- A. Remove foreign materials before erection. Ream ends of piping to remove burrs.
- B. Install piping parallel to building walls and ceilings and at such heights so as not to obstruct any portion of window, doorway, stairway, or passageway. Install piping to allow adequate service space for equipment. Refer to drawings and/or manufacturer's recommendations. Install vertical piping plumb. Where interferences develop in field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings or other Architectural details before installing piping.
- C. Provide anchors, expansion joints, swing joints and expansion loops so that piping may expand and contract without damage to itself, equipment or building.
- D. Mitered elbows, welded branch connections, notched tees and "orange peel" reducers are not allowed. Unless specifically indicated, reducing flanges and reducing bushings are not allowed. Reducing bushings may be used for air vents and instrumentation connections.
- E. Unless otherwise indicated, use fittings as specified in Part 2 of this Section for elbows, tees, reducers, etc.
- F. Install drains throughout systems to permit complete drainage of entire system.
- G. Do not install piping over electrical panelboards, switchgear, switchboards or motor control centers.
- H. Install valves, control valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide reducing fittings for valves smaller than pipe size.
- I. Make connections to all equipment installed by others where that equipment requires piping services indicated in this Section.
- J. "Weldolets" with outlet size 2-1/2" and larger and "Threadolets" or "Sockolets" with outlet size 2" and smaller may be used for branch takeoff up to one pipe size smaller than main. Use

"Threadolets" where threaded fittings are specified and use "Sockolets" where socket weld fittings are specified. Install in accordance with PFI (Pipe Fabrication Institute) Standard ES49.

- K. Provide temporary bypasses and valves at all equipment locations to facilitate the flushing of the pipe system during construction. Flushing must occur before connecting to AHUs, coils or boilers.

3.02 THREADED PIPE JOINTS

- A. Threads of pipe and fittings shall conform to ASME B1.20.1.
- B. Ream pipe ends after cutting and clean before erection. Apply thread sealants to cleaned male threads. Assemble joint to appropriate depth and remove any excess pipe joint compound from tightened joint.

3.03 FLANGED JOINTS

- A. Clean flange surfaces and align them parallel. Bolt holes of gaskets shall be cut slightly larger than bolt diameter. Gasket ID shall be slightly larger than flange ID.
- B. Position gasket concentrically so compression is equally distributed over entire gasket surface.
- C. Lubricate bolts and run nuts down by hand.
- D. By using torque wrench, tighten nuts in the proper sequence so gasket is compressed evenly, and to the appropriate torque specified by bolt manufacturer.
- E. Re-torque bolts 12 to 24 h after start up.

3.04 WELDED PIPE JOINTS

- A. Inspect pipe and pipe fittings for roundness before they are fit-up or set in place.
- B. Properly clean and prepare pipe base material before fit-up. Verify joint land and bevel.
- C. Preheat pipe base material as required by welding procedure specification. Temperature of pipe material must be minimum of 32°F before welding.
- D. Properly align and adjust joint as required by welding procedure and thickness of material. Verify tolerances after tacking sequence.
- E. Use weld material diameter as procedurally required for type and thickness of work being done.
- F. Use sufficient argon pre-purge and argon post-purge for GTAW processes. Post purge should be until weld is no longer glowing plus 5 seconds. Maintain purge for at least 2 layers of weld material.
- G. Properly store welding materials.
- H. Clean tacks before welding out. Remove slag after each pass by grinding to avoid slag inclusion.
- I. Weld reinforcement shall not exceed limits established in Chapter V of ASME B31.1.
- J. Brush each weld free of rust and paint with rust resistant product that matches piping surface color.
- K. For piping within scope of ASME B31.1, each weld shall be permanently marked by welder performing weld. Each welder shall sign and date field welding log record for all welds performed by welder as indicated in Part 1.

3.05 COPPER PIPE JOINTS

- A. Cutting of tubing shall not make tubing out of round. Ream cut tube ends to full inside diameter.
- B. Remove slivers and burrs remaining from tube cut by reaming and filing both pipe surfaces. Clean fitting and tube with emery or sand cloth. Remove residue from cleaning operation, apply flux and assemble joint. Use solder or brazing to secure joint as specified for specific piping service.

3.06 WATER SYSTEMS

- A. Pitch horizontal mains up at 1" per 40 ft in direction of flow. Install manual air vents at all high points where air may collect. If vent is not in accessible location, extend air vent piping to nearest code acceptable drain location with vent valve located at nearest accessible location to pipe.
- B. Main branches and runouts to terminal equipment may be made at top, side or bottom of main provided that there are drain valves suitably located for complete system drainage and manual air vents are located as described above.

- C. Unless otherwise indicated, for upfeed risers, use top or top 45° connection to main and for downfeed risers use side or bottom 45° connection to main. If side or bottom 45° connection is not practical and bottom connection to main must be used, provide line size Y strainer with shut-off valve at each side at branch connection.
- D. Use minimum of 3 elbows in each pipeline to terminal equipment to provide flexibility for expansion and contraction of piping systems. Offset pipe connections at equipment to allow for service, such as removal of terminal device.
- E. Use concentric fittings for changes in pipe sizes and for valves smaller than pipe sizes.

3.07 COOLING COIL CONDENSATE DRAIN

- A. Trap each cooling coil drain pan connection with trap seal of sufficient depth to prevent conditioned air from moving through piping. Extend drain piping to nearest code approved drain location. Construct trap with plugged tee for cleanout purposes.
- B. Pitch pipe down at 1/4" (6.5 mm) per one foot for proper drainage.
- C. Traps and plugged tee cleanouts shall not be located directly under or in front of air handling unit access doors. If drain pan connections are located under access doors, offset drain piping and route as required to provide clear, unobstructed access under and in front of the access door. Pitch offsets as required for drainage.

3.08 RAW WATER MAKE-UP

- A. Refer to Section 22 1118 - Water Distribution System
- B. Install piping where indicated, including valves, piping specialties and dielectric unions required for functional system.
- C. Raw water make-up piping for this Section is defined as fill line containing pressure reducing valve for water systems.

3.09 CHEMICAL TREATMENT

- A. Install piping as indicated on drawings, as detailed, and as recommended by supplier of chemical treatment equipment.

3.010 VENTS AND RELIEF VALVES

- A. Install vent and relief valve discharge lines as indicated on drawings, as detailed, and as specified for each specific valve or piping specialty item.

3.011 DIELECTRIC FITTINGS

- A. Install dielectric, flanges or fittings in main and branch piping of water systems at each point where copper to steel pipe connection occurs. Dielectric fittings shall not be used at terminal device connections.
- B. Concealed dielectric fittings are not allowed.
- C. Install steel to steel pipe dielectric flanges in chilled water piping at each point where interior steel piping is connected to exterior underground steel piping.

3.012 UNIONS AND FLANGES

- A. Install union or flange at each automatic control valve and at each piping specialty or piece of equipment that requires tube pull or removal for maintenance, repair or replacement. If required, provide additional unions or flanges in order to facilitate removal of piping sections that interfere with tube pulls or equipment removal. Where valve is located at piece of equipment, provide flange or union connection on equipment side of valve.
- B. Concealed unions or flanges are not allowed.

3.013 SYSTEMS STARTUP

- A. All piping systems shall be cleaned, tested, and accepted by the Engineer prior to being placed in service.

3.014 SITE QUALITY CONTROL

- A. Inspection
 - 1. Engineer will witness piping systems' pressure test.
 - 2. Notify Engineer at least 24 hours in advance of each inspection.

3.015 REFRIGERANT PIPING

- A. Solder joints shall be ASTM Grade 4 or 5 and have melting point of approximately 1,250°F. Solder impurities shall not exceed 0.15%. Tubing shall be new and delivered to job site with original mill end caps in place. Clean and polish joints before soldering. Avoid prolonged heating and burning during soldering. Purge pipes with nitrogen during soldering. Provide manual shut-off and check valves as required.
- B. Leak test by charging system to pressure of 10 psig with the same type of refrigerant that will be used in the system.
- C. Charge refrigerant into system through Sporlan catchall filter-drier. Finally increase pressure to 300 psig with oil pumped dry nitrogen. Rap joints with rubber or rawhide mallet and check for leaks with electric leak detector having certified sensitivity of at least one ounce per year. Seal any leaks that may be found and retest.
- D. After completion of leak test, evacuate system with vacuum pump to 2.5 mm Hg absolute as measured on accurate gauge.
- E. System ambient temperature shall be above 60°F during evacuation, charge refrigerant into system to 0 psig, then repeat evacuation to 2.5 mm Hg absolute. Allow system to stand evacuated for at least 12 h. If no noticeable rise in pressure occurs, system may be charged.
- F. Charge system with new refrigerant through charging valve and filter-drier. Continue charging until bubbles disappear from liquid line sight glass while compressor is in operation.
- G. Refrigeration piping must be installed by firms who are experienced in installation of such piping.

3.016 PIPING SYSTEM PRESSURE TESTS

- A. Owner and/or Owner's representative may elect to witness pressure test. Notify Owner and/or Owner's representative at least 3 days in advance.
- B. Conduct pressure test prior to flushing and cleaning of piping systems.
- C. Conduct hydrostatic (HYDRO) test in accordance with ASME B31.1 137.4. Test pressure shall be in accordance with ASME B31.1, but shall not be lower than the minimum test pressure listed below.
- D. If leaks are found, repair with new materials and repeat test until leaks are eliminated. Caulking will not be acceptable.
- E. Pressure tests may be made of isolated portions of piping systems to facilitate general progress of installation. Any revisions made in piping systems require retesting of affected portions of piping systems.
- F. No systems shall be insulated until it has been successfully tested. If required for additional pressure load under test, provide temporary restraints at expansion joints or isolate them during test. Unless otherwise noted, minimum test time shall be 4 h plus such additional time as may be necessary to conduct examination for leakage.
- G. No pressure drop shall occur during test period. Any pressure drop during test period indicates leakage.
- H. Provide pumps, gauges, instruments, test equipment, temporary piping and personnel required for tests and provide removal of test equipment and draining of pipes after tests have been made.
- I. For hydrostatic tests, remove air from piping being tested by means of air vents. Measure and record test pressure at high point in system. Where test pressure at high point in system causes excessive pressure at low point in system due to static head, portions of piping system may be isolated and tested separately to avoid undue pressure. However, every portion of piping system must be tested at the specified minimum test pressure.
- J. Conduct pressure tests with parameters indicated below:

<u>System</u>	<u>Minimum Test Pressure</u>	<u>Remarks</u>
Heating hot water	100 psig	HYDRO

3.017 FLUSHING AND CLEANING PIPING SYSTEMS

- A. Notify Owner and/or Owner's representative at least 7 days in advance.
- B. Flush new water, fluid, steam and condensate systems thoroughly for 15 minutes or longer, as required to ensure removal of dirt and foreign matter from piping system. Bypass pumps and equipment and remove strainers from strainer bodies. Provide circulation by Contractor-supplied portable pumping apparatus.
- C. Provide temporary piping or hose to bypass coils, control valves, heat exchangers, other factory-cleaned equipment, and any component that may be damaged.
- D. Sectionalize system to obtain minimum velocity of 6 fps. Provide temporary piping to connect dead-end supply and return headers as necessary. Flush bottoms of risers.
- E. After initial flushing of system, use portable pumping apparatus to circulate cold water detergent for water systems. Refer to Section 23 2514 - Chemical Treatment Systems for pipe cleaning.
- F. After initial flushing of system, use portable pumping apparatus for continuous 24 h minimum circulation of cold water detergent similar to Nalco 2567 cleaner. Flush detergent clear with continuous draining and raw water fill for additional 12 h or until all cleaner is removed from system. Replace strainers and reconnect permanent pumping apparatus and all apparatus bypassed.
- G. Refer to Section 23 2514 - Chemical Treatment Systems for water analysis.

3.018 INITIAL SYSTEM FILL AND VENT

- A. Fill and vent systems with proper working fluids.
- B. Use fluids chemically treated as specified in Section 23 2514 - Chemical Treatment Systems.

3.019 PIPE PAINTING

- A. Exposed exterior and exposed interior (mechanical rooms) carbon steel, black iron or other ferrous pipe, fittings, and pipe supports shall be prepared and painted by qualified painters using corrosion inhibitive paints. Pipe shall be prepared in accordance with paint manufacturer's instructions and primed (2 coats) and finish painted (2 coats). Paint type shall be approved by Architect/Engineer.
- B. Protect piping from weather and paint promptly to prevent corrosion.

END OF SECTION

**SECTION 23 2118
VALVES**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 23 0700 - Mechanical Systems Insulation
- B. Section 23 2120 - Piping Specialties

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

- A. Shop Drawings for each system for all sizes including, but not limited to, the following:
 - 1. Name of system
 - 2. Manufacturer's name
 - 3. Type
 - 4. Model number
 - 5. Materials of construction
 - 6. Temperature/pressure ratings
 - 7. Manufacturer's data sheets clearly cross-referenced
 - 8. All other appropriate data

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Gate valves, globe valves, check valves, and drain valves: Crane, Nibco, Stockham, Powell, Milwaukee, Hammond, or Grinnell equal to manufacturer's Figure number listed. Provide valves of same make for these services.
- B. Other valves: acceptable manufacturers and Figure Number listed under each item.

2.02 WATER SYSTEM VALVES

- A. General:
 - 1. Valves 2" and smaller in steel piping shall have threaded ends.
 - 2. Valves 2" and smaller in copper piping shall have solder ends.
 - 3. Provide valve stem extensions with sufficient length to allow for insulation where insulation is specified.
- B. Ball Valves:
 - 1. 2" and Smaller: ASTM B584 bronze body, chrome plated brass/bronze or stainless steel ball, full port for 3/4" and smaller and conventional port for 1" and larger, Teflon seat rings, blowout-proof stem, 2-piece construction, 600 psi WOG, 150 psi SWP, Nibco Fig. T(S)-580-70, Apollo No. 70, Watts, Milwaukee BA-150, Hammond, FNW or Anvil
- C. Spring Loaded Check Valves:
 - 1. 2" and Smaller: bronze or iron body, Class 125 (200 psi WOG), Nibco Figure T(S)-480, Mueller Figure 303-AP or Metraflex No. 700
 - 2. 2-1/2" and Larger: cast iron or ductile iron body, flanged or wafer type, 302/304 or 316 stainless steel spring, aluminum bronze, carbon steel or ductile iron totally encapsulated in EPDM disc, Buna-N or electroless nickel plated seat, Class 125 (200 psi WOG), Nibco Figure F-910 or W-910, Milwaukee 1800 or 1400, Metraflex No. 700, Stockham Figure WG-970, Mueller Sure Check Model No. 71, or Crane Duo-check II
- D. Shut-Off Valves:
 - 1. 2" and Smaller: ball valves as specified in this Section
 - 2. 2-1/2" and Larger: butterfly valves as specified in this Section
- E. Balancing Valves:
 - 1. 2" and Smaller: calibrated balancing valves:

- a. Variable orifice with multiple turn valve type as manufactured by Armstrong Series CBV or ABV, Tour & Andersson (Victaulic) Series 786 or 787, NIBCO 1709 or 1710, or fixed orifice with ball valve type as manufactured by IMI Flow Design, Hays, Nexus, HCl or Taco. (Taco Accu-Flo is Basis of Design). Bronze or brass body, 250 psi maximum working pressure, 250°F maximum operating temperature. Furnish valve with adjustable memory stop and quick disconnect taps with built-in check valve for pressure differential measurement, integral valve setting index and memory locking device.
 - b. Valves shall measure down to 0.3 gpm with accuracy of $\pm 5\%$.
 - c. Valves shall be leak-tight at full rated working pressure.
 - d. Unless otherwise indicated, size balancing valves so that at design flow rate, pressure drop across balancing valve with valve approximately 50% open will be at minimum 25% of reading range of meter used for balancing.
2. 2-1/2" and Larger: Armstrong Series CBV or Tour and Anderson (Victaulic) Series 788/789, ductile iron body, ASME/ANSI B16.42 Class 150 flange, 250 psi maximum working pressure, 250°F maximum operating temperature. Fixed orifice with ball valve or butterfly valve as manufactured by FDI, Presco or Gerand, Class 150 flange, 225 psi maximum working pressure, 250°F maximum operating temperature will be acceptable up to 4" size.
 3. Furnish portable meter kit within durable case similar to Gerand Model "R". Furnish meter with minimum 4-1/2" diameter aluminum or brass body/brass internals with reading range of either 0" to 50" or 0" to 100" water column differential as appropriate, 200°F maximum temperature, 300 psi working pressure. Meter accuracy shall be $\pm 2\%$ full scale. Provide in kit: equalizing valves, 10 ft purge hose and size devices specified. Meter shall become property of Owner.
 4. Contractor shall furnish meter for calibration and shall retain meter after final calibration.
- F. Butterfly Valves:
1. 2-1/2" and Larger 20":
 - a. Manufacturers: DeZurik, Keystone, Nibco, Milwaukee, or Bray
 - b. Ductile iron body, stainless steel shaft, aluminum-bronze disc, or Nylon 11 coated ductile iron disc, upper thrust bearing, EPDM resilient seat, rated at 200 psi bidirectional shut-off pressure, suitable for continuous operation at temperature up to 225°F, compatible to ANSI B16.1 Class 125/150 flange standards, conforming to MSS-SP-67.
 - c. Dead end pressure rating shall be 150 psi with no downstream flange/piping attached.
 - d. For valves 6" and smaller, provide 10-position lever actuators with locking devices. For valves 8" and larger, provide rotary hand wheel operators with adjustable position stop and position indicators. Size hand wheel operators with no higher than 80 lb rim pull at full valve pressure rating.
 - e. External disc-to-stem connections using screws or pins are not allowed.
 - f. Valve necks shall be of sufficient length to allow for insulation where insulation is specified. Wheel shaft shall be sufficient length so wheel does not touch insulation.
 - g. Provide full lug type valves permitting removal of downstream piping while using valve for system shut-off.
 - h. Furnish valves used for balancing with adjustable memory stops.
- G. Water Pressure Regulating Valves:
1. Manufacturers: Thrush, Watts, Cash-Acme, Taco, or B & G
 2. Brass or bronze body, spring and diaphragm operated, pressure adjustable with check valve and inlet strainer and designed for maximum working pressure of 125 psig and maximum operating temperature of 160°F.
- H. Lockshield Valves:

1. Ball valves as specified above with locking handles for padlocking in open or closed position.
- I. Drain Valves:
 1. Ball valve as specified above with threaded hose adapter and cap. Provide 3/4" minimum drain valve for piping larger than 1/2", except strainer blowdown valves shall be blowdown connection size. Provide 1/2" drain valve for 1/2" piping. If 3-piece ball valves are specified, use 2-piece ball valves with same construction.

2.03 RELIEF VALVES

- A. Manufacturers: Kunkle, Consolidated, Thrush, Watts, Cash-Acme, Lonergan, Keckley, or B & G. Iron or bronze body, direct pressure actuated, Teflon seat, stainless steel stem and spring, and suitable for maximum working pressure of 125 psig at 240°F.
- B. Valves to conform to State Requirements and have ASME Stamps.

2.04 GAUGE VALVES

- A. Unless otherwise indicated, gauge valves for steam, steam condensate and feedwater services shall be gate valves. Gauge valves for all other services shall be needle ball valves. Gauge valve size shall match gauge pipe size as specified in Section 23 2116 - Pipe and Pipe Fittings.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install valves as shown on plans, details and according to manufacturer's installation recommendations.
- B. After piping systems have been pressure tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust, replace packing or replace valves to stop leaks.
- C. Install control valves furnished under Control Systems. Provide reducer and increaser fittings as required.
- D. Refer to Section 23 2116, Part 3 for reducing fittings requirement for valves smaller than pipe size.
- E. Provide chain operators for manually operated valves 4" and larger, located more than 8 ft above equipment room floor.

3.02 SHUT-OFF VALVES

- A. Provide shut-off valves at all equipment, at riser take-offs at each floor, and at each automatic valve for servicing.
- B. Install steam system shut-off valves in horizontal piping. Shut-off valves are not allowed in vertical piping.

3.03 BALANCING VALVES

- A. Provide balancing valves where indicated on drawings and as required for complete balancing of water systems.
- B. Provide straight inlet and outlet pipe length in accordance with manufacturer's recommendation.

3.04 GAUGE VALVES

- A. Provide gauge valves at each pressure gauge as shown and at each pressure tapping where pressure sensing tubing is connected.

3.05 DRAIN VALVES

- A. Provide drain valves at all low points of piping systems for complete drainage of systems.
- B. Unless otherwise indicated, provide 1/2" drain valve for 1/2" piping and minimum 3/4" drain valve for 3/4" and larger piping, except strainer blowdown valves shall be blowdown connection size.

3.06 WATER PRESSURE REGULATING VALVES

A. Set valves for pressure required or as scheduled.

3.07 RELIEF VALVES

A. Unless otherwise indicated, provide one relief valve in each closed water system in the pump inlet piping.

3.08 SPRING LOADED CHECK VALVES

A. Provide spring loaded check valve in each pump discharge line.

END OF SECTION

**SECTION 23 2120
PIPING SPECIALTIES**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 23 0594 - Water Systems Test Adjust Balance
- B. Section 23 2118 - Valves

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 REFERENCE STANDARDS

- A. Metal bellows expansion joints shall be constructed and applied in accordance with "Standards of the Expansion Joint Manufacturer's Association", 8th Edition, 2003.

1.04 SUBMITTALS

- A. Shop Drawings for all items in this Section including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Identification as referenced in the Documents
 - 3. Materials of construction
 - 4. Dimensional data
 - 5. Capacities/ranges
 - 6. Temperature/pressure ratings
 - 7. Pressure drop
 - 8. All other appropriate data.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Unless otherwise specified, select devices for highest pressures and temperatures existing in respective systems in accordance with ANSI Specifications.
- B. Piping specialties in copper piping shall have bronze or brass body with solder ends.

2.02 THERMOMETERS

- A. Manufacturers: Taylor, Trerice, Weksler, Miljoco, Winters, or Weiss
- B. Pipeline mounted thermometers: 9" scale cast aluminum case and frame, clear acrylic plastic window front, permanently stabilized glass tube with mercury free indicating fluid, adjustable angle stem, extended neck suitable for insulated piping as required, and compatible with sockets as specified herein.
- C. Thermometers used in duct reheat coil piping: Bi-metal adjustable type, 3" dial, equal to Trerice B836 or Weiss 3VBM.
- D. Range of thermometers shall be:

<u>Service</u>	<u>Scale Range</u>	<u>Increment</u>
Heating Hot Water	30°F to 240°F	2°F
Air (indoor)	0°F to 160°F	2°F
Air (outdoor)	(-40°F to 100°F)	2°F

- E. Thermometers by temperature control manufacturer meeting above Specification will be acceptable.

2.03 THERMOWELLS AND TEST WELLS

- A. Trerice 5550 Series or approved equal.
- B. Brass construction with threaded connections suitable for thermometer stems or bulbs and temperature control sensing elements, well length suitable for pipe diameter with extended neck as required to suit pipe insulation. For test well, furnish with brass cap and short chain to secure cap to body.

C. Stainless steel construction for stainless steel piping.

2.04 PRESSURE GAUGES

- A. Manufacturers: Ashcroft, U.S. Gauge, Marsh, Trerice, Miljoco, Marshalltown, Weksler, Winters or Weiss equal to Trerice 600 Series
- B. Minimum 4-1/2" diameter die cast aluminum case, glass or acrylic plastic window, phosphor bronze bourdon tube with bronze bushed movement, recalibration from front of gauge dial and 1/4" NPT forged brass socket.
- C. Gauge accuracy shall meet ANSI B40.100 Grade 1A ($\pm 1\%$ full scale).
- D. Reading range of gauges shall be:

<u>Service</u>	<u>Scale Range</u>
Heating Hot Water	0 to 100 psig

- E. Pressure Snubbers:
 - 1. 1/4" or 1/2" size, matching gauge pipe size as specified in Section 23 2116 - Pipe and Pipe Fittings, 1000 psig WP. Brass for carbon steel pipe or copper pipe. Stainless steel for stainless steel pipe.
- F. Coil Syphons:
 - 1. 1/4" or 1/2" size, matching gauge pipe size as specified in Section 23 2116, 500 psig WP. Material shall match gauge pipe material.

2.05 PRESSURE/TEMPERATURE TEST STATIONS

- A. Pete's plugs made by Peterson Equipment Company, Sisco, Super Seal by Flow Design Inc. (FDI), or approved equal.
- B. Test plugs shall be 1/4" or 1/2" NPT, brass body and cap, 1-1/2" length for non-insulated pipe and 3" length for insulated pipe, with Nordel self-closing valve cores, rated at 500 psig at 275°F, and shall receive either temperature or pressure probe with 1/8" OD.
- C. Furnish portable test kit within durable case containing the following:
 - 1. A compound pressure gauge, 3-1/2" dial, 30" Hg – 100 psi, field calibration screw, surge protector and stainless steel gauge adapter with 1/8" diameter probe (2% accuracy of mid range).
 - 2. Two pocket testing thermometers, 1-3/4" dial, 5" long stainless steel stem, 0 - 220°F and 25 - 125°F ranges with external calibration (1% accuracy of entire scale).

2.06 PIPE EXPANSION DEVICES

- A. Expansion Loops:
 - 1. Size expansion loops including L-bends and Z-bends as indicated on drawings or as scheduled.
 - 2. Size expansion loops including L-bends and Z-bends to allow adequate expansion of main straight runs of system within stress limits specified in ANSI B31.1.

2.07 PIPELINE STRAINERS

- A. Manufacturers: Metraflex, Mueller Steam Specialty, Nibco, Hoffman, Eaton (formally Hayward), Sarco, Keckley, Armstrong, Wheatley, Conbraco, Titan, or Streamflo
- B. Liquid System:
 - 1. 2" and Smaller: full pipeline size, Y-type, with removable screen caps, cast iron, Class 250 (400 psi/150°F WOG), threaded ends for carbon steel piping and cast bronze, Class 150 (200 psi/150°F WOG), solder ends for copper piping. Screen caps shall have threaded blowdown connection.
 - 2. 2-1/2" and Larger: full pipeline size, Y-type, Class 125 (200 psi/150°F WOG), cast iron, flanged ends. Furnish strainer with bolted screen retainer and off-center blowdown connection.
 - 3. Liquid Service Screens: stainless steel with screen perforation as indicated below. For strainers serving equipment where manufacturer requires specific screen perforation,

provide per manufacturer requirements. Maximum pressure drop shall be 4 ft WG through clean strainer.

<u>Pipe Size</u>	<u>Closed System</u>	<u>Open System</u>
2" and smaller	1/32" (20 mesh)	1/8"
2-1/2" to 4"	1/16"	1/8"
5" and over	1/8"	1/8"

2.08 EXPANSION TANKS

- A. Manufacturers: Amtrol, Taco, Bell and Gossett, Armstrong, Wheatley, or Wessels
- B. Tanks shall be replaceable bladder type air pre-charged to initial fill pressure as scheduled. Furnish tank suitable for 125 psig WP, constructed, tested and stamped in accordance with ASME Code, and sealed-in elastomer bladder suitable for operating temperature of 240°F. Bladder shall be compatible with water and with ethylene and propylene glycol. Furnish mounting saddles for horizontal tanks and mounting base for vertical tanks. Furnish tanks with system connections; drain connections for floor-mounted tanks, and air charging valves.

2.09 AIR SEPARATORS

- A. Manufacturers: Bell and Gossett, Amtrol, Armstrong or Taco
- B. 1-1/2" and Smaller: Cast iron construction with steel diffuser tube, bottom and side threaded inlet connections, bottom and top threaded outlet connections, threaded top connection for air elimination, designed for maximum 125 psig WP.
- C. 2" and Larger:
 - 1. Centrifugal type, cast iron or carbon steel construction, flanged connection, threaded connections acceptable for 3" and smaller, perforated stainless steel air collector tube to direct air toward air elimination connection at top of unit, inlet and outlet connections tangential to vessel shell, bottom blow down connections, constructed and stamped in accordance with ASME Boiler and Pressure Vessel Code for 125 psig design pressure at 350°F.
 - 2. Vessel shell diameter shall be at least 3 times nominal inlet/outlet pipe diameter.
 - 3. Manufacturer's data sheet shall include air collection efficiency and pressure drop at design flow scheduled.

2.010 AIR AND DIRT SEPARATORS

- A. Manufacturers: Taco, Spirovent or approved equal. Eliminators by Caleffi and Wessels will be acceptable, provided units meet the specified requirements.
- B. Coalescing type combination air and dirt separator, designed for maximum 150 psig WP, stamped and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels. Connections 2" and larger shall be flanged. Smaller connections may be flanged or threaded. Inlet size shall be no smaller than scheduled size. Inlet velocity shall be 4.0 feet per second or less, except where model VHN or VHR is indicated, velocity may be in the range of 4.0 to 10.0 feet per second.
- C. Coalescing medium shall consist of copper core tube with continuous wound copper wire permanently attached and followed by a separate continuous wound copper wire permanently affixed or stainless steel. Submittal shall show that medium fills the entire vessel above and below relatively smaller chambers for dirt collection and venting, respectively. Partial fill is not acceptable.
- D. Air elimination efficiency shall be 100% of free air, 100% of entrained air, and 99.6% of dissolved air.
- E. Dirt separation efficiency shall be 80% of particles 30 microns and larger within 100 passes.
- F. Venting chamber shall be provided with integral full port float actuated brass venting mechanism.
- G. Unit shall include valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.

- H. Drain valve at bottom of unit for flushing/dirt removal, 1" for units size 12" and smaller, 2" for units size 14" and above.

2.011 PUMP SUCTION DIFFUSERS

- A. Manufacturers: Bell & Gossett, Armstrong, Mueller Steam Specialty, Wheatley or Taco
- B. Cast iron or ductile iron body with angle pattern flow straightening vanes and combination diffuser-strainer-orifice cylinder with 3/16" diameter openings, 175 psig WP, at 250°F. Threaded ends for 2" and smaller and flanged ends for 2-1/2" and larger. Orifice cylinder shall have free area of at least 5 times cross section area of pump suction opening. Furnish each unit with disposable fine mesh start-up strainers, gauge tappings, blow down connection, and adjustable support foot to carry weight of suction piping.

2.012 AIR VENTS

- A. Manual Air Vents:
 - 1. Manufacturers: Bell & Gossett Model 4V, 125 psig at 210°F or approved equal. Use 1/2" ball valve for main pipes.
- B. Automatic Air Vents:
 - 1. Manufacturers: Amtrol, Watson McDaniel, B&G, or Hoffman
 - 2. Metal construction, non-corrosive working parts, 150 psig WP at 240°F
 - 3. Normal capacity vent shall be similar to B&G Model 87
 - 4. High capacity vent shall be float actuated and shall have minimum air elimination rate of 10 cfm at 100 psig, similar to B&G Model 107A.

2.013 FLOW ELEMENTS (MEASURING STATIONS)

- A. Venturi Flow Elements:
 - 1. Manufacturers: Hyspan, Gerand, or Preso
 - 2. Elements shall be flanged ends for 2-1/2" and larger and threaded ends 2" and smaller. Furnish tubes with quick disconnect taps and shut off valves, suitable for 125 psig WP. Select tubes for size and pressure drop as scheduled and tag for mark number, flow and pressure drop as specified.
 - 3. Provide portable meter kit within durable case. Furnish with 6" diameter forged brass meter having dial range from 0" to 50" WG. Provide in kit equalizing valves, vent hose and size devices specified. Meter shall become property of Owner.
 - 4. Contractor shall furnish meter for calibration and shall retain meter after final calibration.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install piping specialties as indicated on plans, details and according to manufacturer's recommendations.

3.02 THERMOMETERS

- A. Install thermometers in thermowells in locations indicated.

3.03 THERMOMETER TEST WELLS

- A. Install test wells in locations as shown and at each point where temperature-sensing device is required under Control Systems.

3.04 PRESSURE GAUGES

- A. Install gauges for services other than steam with pressure snubbers and gauge valves.
- B. Install gauges for steam service with coil syphons and gauge valves.

3.05 PRESSURE GAUGE TAPPING

- A. Install tappings with gauge valves at each point where sensing device is required under Control Systems and at gauge locations as shown.
- B. Use threadolets or tee fittings to mount gauge tappings or test stations. Install fittings for side mounting to avoid collection of air or dirt.

3.06 PRESSURE/TEMPERATURE TEST STATIONS

- A. Pete's plug may be used in lieu of thermometer test well and pressure gauge tappings.
- B. Use threadolets or tee fittings to mount gauge tappings or test stations. Install fittings for side mounting to avoid collection of air or dirt.
- C. Provide a Pete's plug adjacent to each BAS pressure sensor or temperature sensor even if they are not specifically shown in the plans. The Pete's plugs are to be used for the calibration of the BAS sensors.

3.07 PIPE EXPANSION DEVICES

- A. Stretching of expansion joints or connectors to correct for piping misalignment is not allowed.
- B. Install expansion loops, L-bends, Z-bends, and compensators where shown on drawings and as necessary to allow expansion and contraction in piping systems.

3.08 PIPELINE STRAINERS

- A. Provide drain valve at each strainer blowdown connection with hose threaded adapter and cap. Valve size shall be same as blowdown connection size.
- B. Install strainers in steam system on entering side of all automatic control valves and as indicated elsewhere. Install Y-type strainers in horizontal lines so that basket is in horizontal plane to prevent condensate build-up in basket.
- C. Install strainers in water systems on suction side of all pumps, entering side of automatic control valves of heating and cooling coils of air handling units, and as indicated elsewhere.

3.09 AIR SEPARATORS

- A. Provide valved blow down connections and extend drain piping to nearest floor drain.

3.010 PUMP SUCTION DIFFUSERS

- A. Pipe blow down to the nearest floor drain with drain valve at unit.
- B. Remove disposable fine mesh start-up strainers after start-up. Clean permanent strainer and replace after pipe cleaning process.

3.011 AIR VENTS

- A. Install manual air vents at all high points in water systems where air may collect and where shown on drawings. Manual air vent valve outlets are to be provided with a threaded brass plug.
- B. Install automatic air vent at top of air separator and where shown on drawings. Provide shut-off valve to isolate air vent from system. Pipe automatic air vent to the nearest floor drain.

3.012 FLOW ELEMENTS/FLOWMETERS

- A. Flow elements/flowmeters located in common piping after multiple pump discharge lines shall be furnished with hot tap feature.
- B. If flow elements/flowmeters are furnished by Control Contractor, this Contractor shall install them in accordance with manufacturer's installation instructions. Wiring of flowmeters will be provided by Control Contractor.

END OF SECTION

**SECTION 23 2123
PUMPS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 22 0513 - Motors
- B. Section 22 0514 - Variable Frequency Drive (VFD) System
- C. Section 23 0550 - Vibration Isolation
- D. Section 23 2120 - Piping Specialties

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

- A. Shop Drawings including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Identification as referenced in the documents
 - 3. Capacities/ratings
 - 4. Pump curves with operating point clearly indicated. For parallel pump applications, indicate operating point of combined case as well as operating point of only one pump.
 - 5. Motor data (refer to Section 23 0513 - Motors)
 - 6. Seals
 - 7. Materials of construction
 - 8. Dimensions and weights
 - 9. Manufacturer's installation instructions
 - 10. All other appropriate data
- B. Complete equipment data sheet attached at end of this Section for each piece of equipment and submit with Shop Drawings. Shop Drawings will be returned without review if data sheets are not provided for each piece of equipment and if data sheet is not filled out completely.

1.04 DESIGN CRITERIA

- A. Pump sizes, capacities, pressures and operating characteristics shall be as scheduled.
- B. Pumps shall meet or exceed operating efficiencies scheduled.
- C. Furnish pumps complete with motors, impellers, drive assemblies, bearings and accessories as hereinafter specified. Furnish pump couplings with OSHA compliant coupling guards.
- D. Where pump is indicated for parallel operation, scheduled conditions are for that pump with two pumps operating; i.e., total system flow rate is twice that scheduled for single pump. When only one of two pumps is operating, operating point of that pump must fall within manufacturer's recommended operating range.
- E. Select motor with sufficient hp rating for non-overloading operation over entire pump curve.
- F. Furnish each pump and motor with nameplate giving manufacturer's name, serial number of pump, capacity in gpm and head in ft at design condition, hp, voltage, frequency, speed and full load current.
- G. Test pumps hydraulically at 150% of rated pressure per Hydraulic Institute Standards, clean and paint before shipment. Manufacturer shall certify all pump ratings.
- H. Pumps shall operate without objectionable noise or vibration.
- I. After completion of balancing, if water balancing results in pump discharge balancing valve being closed 50% or more, replace or trim impeller so that balancing valve is opened at least 75% to maintain design flow rate. Where pumps are driven by VFDs, balancing should be performed with pumps at design speed.
- J. Furnish one spare seal for each pump to Owner.

- K. Where pumps are located remotely from their controlling VFDs, provide disconnect switches at the pump location. The disconnect shall be designed to shut off the VFD so as to prevent damage to the VFD when turning off a pump at the pump location by opening the disconnect switch.

1.05 FACTORY TESTING

- A. Pump manufacturer shall conduct factory performance testing of completely assembled pump, drive line, motor, and frame base plate unit before shipment for all water system pumps above 25 hp.
- B. Factory performance testing shall be in accordance with Hydraulic Institute, ANSI/HI 1.6-2000, American National Standard for Centrifugal Pump Tests for Acceptance Level A.
- C. For pumps provided with variable speed drives, test shall include operating the assembled unit over the entire variable speed range, variable head, and variable flow performance range contained on submitted pump Shop Drawing performance curves performance window formed between minimum flow and maximum flow limitations established by submitted NPSHR curve. Test each pump at 50 rpm intervals between 100 rpm and maximum design performance rpm specified.
- D. After testing is complete and before pump is shipped, manufacturer shall submit to Engineer for final acceptance, 6 original test reports which present all measured test data. Each original report shall be signed by authorized factory pump Design/Pump Test Engineer.
- E. Signed test reports shall include the following statement:
"Provided that the pump being furnished is operated within the entire window of operating points between the tested speeds, heads, and flows, manufacturer shall warranty the pump against any performance loss, rotating part damage, stationary part damage, or structural damage caused by mechanically induced or fluid induced vibration occurring within the pump or within the foot print of the pump frame base plate." This warranty includes all materials and labor to repair the pump for a period extending 12 months after final acceptance of the system.

PART 2 - PRODUCTS

2.01 END SUCTION CENTRIFUGAL PUMPS (FLEXIBLE COUPLED)

- A. Manufacturers: Taco, Armstrong, Peerless, Aurora, PACO or Goulds
- B. Pumps shall be base mounted, end suction, flexible coupled, cast iron casings with ANSI Class 125 flange, bronze fitted with working pressure of 175 psi and continuous operating temperature of 225°F. Pumps shall be back pull out design allowing for servicing of impeller and bearing assembly without disturbing piping, motor or requiring shaft realignment.
 - 1. Pumps scheduled to have higher working pressure than 175 psi shall have ductile iron casing with ANSI Class 250 flanges, rated for 300 psi working pressure and continuous temperature of 225°F.
- C. Casings shall have tapped and plugged openings for vent, drain, and suction and discharge gauge connections.
- D. Impellers shall be single suction enclosed type made of bronze, hydraulically and dynamically balanced to ANSI/HI 1.1-1.5-1994, Section 1.4.6.1.3.1, Figure 1.106 Balance Grade G6.3, keyed and locked to pump shafts and protected by replaceable bronze shaft sleeves.
- E. Pump shafts shall be 416 stainless steel, sealed and gasketed from pumped fluid.
- F. Hot water pumps shall be furnished with mechanical seals with carbon rotating faces, ceramic stationary seats, Buna-N elastomer and 316 SS spring, rated up to 225°F continuous operation.
- G. Bearing assemblies shall be cast iron with regreasable ball bearings
- H. Spacer type couplings or couplings with extended hubs shall be used to allow for pump servicing. Couplings shall be Woods Dura-Flex or Sure-Flex in accordance with manufacturer's recommendation for their application.
- I. Pumps shall be furnished with groutable steel base plates

- J. Pump bases shall be furnished with drip pans and drain connections for pumps with packed stuffing box shaft seals.
- K. Provide cast iron suction diffusers at the inlet of each pump.
- L. Pumps and bases that are installed in an exterior application shall be provided with a factory applied corrosion inhibiting epoxy paint.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install pumps in strict accordance with manufacturer's instructions to avoid any stress and misalignment.
- B. Set base mounted pumps on concrete bases, or concrete inertia base, level and bolt down prior to grouting. Fill entire base with non-shrinking grout. Use end caps during grouting to prevent overflow when end caps are not integral with base plates.
- C. Align flexible coupled pumps after base grouting is complete. Align pump and motor in all four planes: vertical angular, horizontal angular, vertical parallel and horizontal parallel. Alignment shall be within the recommended value by manufacturer, but not over 1/64" for parallel alignment and 1/64 per inch of coupler radius for angular alignment. Record and submit all results of alignment procedure to Engineer. After alignment is complete, pin pump and motor to base.
- D. Install full line size spring loaded check valve and balancing valve in pump discharge piping.
- E. Where pump connection size and indicated line sizes are not identical, provide necessary concentric reducers/increasers for vertical piping at pump connection and eccentric reducers/increasers for horizontal piping at pump connection. Install eccentric reducers/increasers with top of pipe level. Valves and piping specialties shall be full line size as indicated on drawings.

3.02 STARTUP

- A. Verify that piping system has been flushed, cleaned and filled.
- B. Prime pump, vent air from casing and verify that rotation is correct. To avoid damage to mechanical seals, never start or run pump in dry condition.
- C. Verify lubrication of motor and pump bearings and lubricate properly in accordance with manufacturer's recommendation and Section 23 0000, Part 3, under LUBRICATION.
- D. After several days' operation, verify removal of disposable startup strainer in suction diffuser and turn them over to Owner.
- E. Perform field mechanical balancing, if necessary, to meet vibration tolerance specified in Section 23 0550 - Vibration Isolation.

END OF SECTION

Pump Data Sheet

General

Project _____
Identification _____
Service _____
Location _____
Type _____
Manufacturer _____
Model Number _____

Performance

Capacity (Flow) _____
Head (Ft) _____
Max. Net Positive Suction Head Req. (Ft) _____
Efficiency (%) _____
Horsepower required for non-overloading
operation over entire pump curve _____

Physical Characteristics

Suction Size _____
Discharge Size _____
Casing Material _____
Impeller Material _____
Shaft Sleeve Material _____
Shaft Material _____
Seal Type _____
Seal Face Material _____
Seal Seat Material _____
Bearing Assembly Material _____
Working Pressure & Continuous Operating Temp. _____
Maximum Intermittent Temperature _____

Motor

Manufacturer _____
Horsepower _____
Voltage _____
Phase _____
Hertz _____
RPM _____
Motor Type _____
Enclosure Type _____
Frame Type _____
Insulation Class _____
NEMA Design Designation _____
Service Factor _____
Nominal Efficiency _____
Nominal Power Factor _____
Full Load Amps _____
Variable Frequency Drive Driven (Yes or No) _____

Miscellaneous

SECTION 23 2514
CHEMICAL TREATMENT SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Control Sequences
- B. Section 23 2116 - Pipe and Pipe Fittings

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

- A. Shop Drawings for each system including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Capacities/ratings
 - 3. Chemicals; description of chemicals, its composition and function
 - 4. Operating sequence
 - 5. Composite wiring diagrams
 - 6. Materials of construction
 - 7. Dimensions and weights
 - 8. Manufacturer's installation instructions
 - 9. All other appropriate data
- B. Submit overall installation diagram for each system locating chemical injecting points, bleed-off assemblies, water meters, number of tanks and pumps, and field piping.
- C. Submit complete make-up water analysis.
- D. Submit directly to Owner, Material Safety Data Sheets (MSDS) for all chemicals used in chemical treatment systems. Include with MSDS written notice of Owner's responsibility to notify its employees of the use of those chemicals.

1.04 OPERATION AND MAINTENANCE DATA

- A. Provide for services of manufacturer's trained, representative to approve installation, and instruct Owner's representative in operation, testing and maintenance of each system.
- B. Include data on chemical feed pumps, meters, and other equipment including spare parts lists, procedures, and treatment programs. Include step-by-step instructions on test and adjust procedures including target concentrations.

1.05 MAINTENANCE SERVICE

- A. Provide service and maintenance of treatment systems for 1 yr from date of substantial completion.
- B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit 2 copies of field service report after each visit.
- C. Provide laboratory and technical assistance services for warranty period.
- D. Provide site inspection of equipment during scheduled shutdown to evaluate success of treatment program. Make recommendations in writing based on these inspections.

1.06 WATER ANALYSIS

- A. Submit complete water analysis and results of performance test of each system signed by manufacturer's service representative.
- B. Water analysis shall include the following:
 - 1. Heating Hot Water:
 - a. Hardness
 - b. pH
 - c. M" alkalinity

- d. Inhibitor level
- e. Total dissolved solids
- f. Temperature

1.07 DESIGN CRITERIA

- A. Periodic test procedure and chemical shall be recommended for each system.
- B. Chemicals shall be suitable for pipe material, fluid medium and intended treatment.
- C. Materials of construction for equipment used shall be compatible with water treatment chemicals provided.
- D. Treat the following systems:
 - 1. Heating Hot water
- E. Provide initial chemical treatment and equipment for all systems based on complete system fluid analysis, including make-up water, prior to equipment installation.
- F. Initial supply of chemicals for chemical treatment of each system shall be adequate for start up and testing period, for the time systems are being operated by Contractor for temporary heating and cooling, and for 1 yr after start-up of system.
- G. Inhibitor for closed water systems shall use nitrites or phosphonate as primary inhibitor.
- H. Chemicals used in condenser water treatment system shall be liquid only and contain no chromates.
- I. Provide electrical devices, wiring and conduit in accordance with the applicable sections of Division 26.

1.08 WATER QUALITY REQUIREMENTS

- A. Minimum water quality requirements for closed loop, heating hot water system shall be as follows:
 - 1. pH 8.0 – 9.0
 - 2. TDS < 500 ppm
 - 3. Hardness as CaCO₃ and Alkalinity < 120 ppm
 - 4. Chlorides < 200 ppm
 - 5. Sulphates < 200 ppm
 - 6. Iron < 1.0 ppm
 - 7. Dissolved Oxygen < 0.1 ppm
 - 8. Ryznar Index > 6.0
 - 9. Suspended Solids ≤ 10 micron
 - 10. Bacteria Counts
 - a. Total Aerobic Bacteria Counts ≤ 100 cfu per mL
 - b. Total Anaerobic Bacteria Counts ≤ 10 cfu per mL

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers:
 - 1. GE Water & Process Technologies (formerly Betz-Dearborn)
 - 2. Ecolab (formerly Nalco)
 - 3. HOH Chemical
 - 4. Earthwise Environmental, Inc.

2.02 PIPING SYSTEM CLEANER

- A. Use cleaning compound to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system metals without deleterious effects. Cleaner shall not contain phosphate.

2.03 HOT WATER CHEMICAL TREATMENT

- A. Provide by-pass type batch feeder to receive chemicals in liquid or pellet form. Each independent hot water heating system shall have separate feeder. Chemical treatment shall control corrosion and scale.
- B. Feeder shall have capacity of 5 gal and shall be constructed of steel with minimum working pressure of 150 psig. Feeder shall be complete with air vent, drain valve, and inlet/outlet pipe connections.
- C. Furnish feeders with screw type cover with replacement gaskets, or valved funnel opening and with exterior prime coat finish.

2.04 TEST CABINET AND EQUIPMENT

- A. Provide complete chemical treatment test equipment and cabinet with appropriate reagent, burettes, and glassware to conduct all tests necessary for determination of proper treatment and blowdown.
- B. Provide detailed, written test procedures for each system in manual with plastic protection cover for each page.
- C. Test equipment shall include but not be limited to, the following:
 - 1. Closed Loop Water System:
 - a. Inhibitor test kits

PART 3 - EXECUTION

3.01 ELECTRICAL WIRING

- A. Provide all field electrical wiring for system, in metal conduit and in accordance with Division 26 and all applicable Electric Codes.

3.02 APPLICATION OF CHEMICALS

- A. Apply initial chemical treatment for each system after systems have been cleaned and flushed.
- B. Add, adjust or modify treatment based on results of period tests until turned over to Owner.

3.03 PERFORMANCE TEST

- A. Conduct performance test for each system to determine required capacity and performance of chemical treatment system. Refer to Part 1 for water analysis and water quality requirements.
- B. Conduct water quality test in all systems weekly and submit test result reports to Mechanical Contractor and Owner until project is turned over to Owner.
- C. Conduct water quality tests before and after new work tie-in to existing systems.

3.04 BATCH FEEDERS

- A. Install in bypass arrangement at pump discharge as indicated.
- B. Install ball valve in inlet line, balancing valve in outlet line and unions.

3.05 PIPE CLEANING

- A. General:
 - 1. Piping systems shall be cleaned before they are used for any purpose except pressure tests, which shall be conducted before cleaning. Add cleaner to closed systems at concentrations as recommended by cleaner manufacturer. Remove water filter elements from system before starting circulation.
 - 2. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer.
 - 3. Remove, clean, and replace strainer screens or filters.
 - 4. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed.
 - 5. New piping system shall not be connected to existing system for operation until flushing and cleaning have been completed. Obtain permission from Owner prior to opening up new work to existing system.
- B. Water Systems:

1. Piping systems shall be filled, vented and circulated employing chemical cleaner solution for period of at least 24 hours or more in accordance with manufacturer's recommendations and job site chemical tests. Bring concentration to level, which raises M Alkalinity to manufacturer's recommended value above that for existing water used for fill. Conduct chemical tests to verify levels and submit results to Architect/Engineer. Flush detergent clear with continuous draining and make-up water fill for period of at least 12 hours or more until original M Alkalinity level is achieved (or until pH of system water is within 0.5 pH of make-up water). Conduct chemical tests to verify levels and submit results to Architect/Engineer. When cleaning process is complete, replace strainers or filters and reconnect permanent pumping apparatus.

END OF SECTION

**SECTION 23 3114
DUCTWORK**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 20 0529 - Mechanical Supporting Devices
- B. Section 20 0700 - Mechanical Systems Insulation
- C. Section 23 0550 - Vibration Isolation
- D. Section 23 0595 - Air Systems Test Adjust Balance
- E. Section 23 3314 - Ductwork Specialties

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

- A. For each duct system, submit schedule utilizing reinforcement tables from SMACNA HVAC Duct Construction Standards where applicable. Each duct system schedule shall include, but not be limited to, the following:
 - 1. Name of Contractor/manufacturer fabricating each duct system
 - 2. Material and gauge
 - 3. Pressure class
 - 4. Transverse joint type and length and reinforcement rigidity class with designated joint T number or proprietary duct connection if utilized for each system
 - 5. Certified test results of proprietary joint products, if used, tested in accordance with SMACNA procedures
 - 6. Intermediate reinforcement spacing and rigidity class with metal angle dimensions and gauge
 - 7. Type of longitudinal seam
 - 8. Fitting construction details
 - 9. Support methods including spacing, upper attachments, and lower attachments
 - 10. Sealant and gasket
 - 11. Sealing class
- B. Duct leakage testing methods, apparatus and apparatus certification signifying meter is in conformance with ASME Requirements for testing meters.
- C. Submit the following information for welded sheet metal ductwork:
 - 1. Welding Procedure Specification (WPS) for welded joints. Form to be similar to ANSI/AWS D9.1-90 Code, Appendix "D".
 - 2. Procedure Qualification Record (PQR) for each WPS. Form to be similar to ANSI/AWS D9.1-90 Code, Appendix "E".
 - 3. Welder Qualification Test Record (satisfactory performance) for each field or shop welder. Form similar to ANSI/AWS D9.1-90 Code, Appendix "F".

1.04 DESCRIPTION

- A. Furnish and erect ductwork free of objectionable vibration, chatter, and pulsations. Verify dimensions at site, making field measurements and drawings necessary for fabrication and erection.
- B. Duct sizes indicated are net inside dimensions.
- C. Where size for a duct segment is not indicated, the duct segment size shall be equal to the largest duct segment to which it is connected. Transition to smaller size shall occur on side of fitting where smaller size is indicated.

1.05 DESIGN CRITERIA

- A. All products shall conform to NFPA 90A, and shall possess flame spread rating of not over 25 and smoke developed rating no higher than 50.
- B. Unless otherwise indicated, construct all ductwork of galvanized sheet metal for pressure class not less than +2" WG (500 Pa) for positive pressure ductwork and not less than -2" WG (-500 Pa) for negative pressure ductwork.
- C. Ductwork shall comply with Local, State and Federal requirements.
- D. Unless otherwise indicated, pressure class for VAV system supply ductwork between supply fan discharge and air terminal device inlet shall be equal to static pressure at fan discharge but not less than 4" WG (1000 Pa); pressure class for ductwork on suction side of air handling unit and suction side of return fan shall be equal to static pressure at inlet of return fan but not less than -2" WG (-500 Pa).
- E. Unless otherwise indicated, pressure class for fume hood exhaust ductwork between exhaust fan inlet and exhaust valve outlet shall be equal to static pressure at exhaust fan inlet but not less than --4" WG (-1000 Pa).
- F. Unless otherwise indicated, pressure class for constant air volume system ductwork shall be equal to external static pressure (fan entrance or discharge pressure minus associated unit internal component pressure drop), but not less than + or - 2" WG (+ or - 1000 Pa).
- G. Duct transverse joints and reinforcement material, including angle ring flanges and stiffeners, shall be of same material as duct.
- H. Except as modified in this Section of specifications, use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA publications:
 - 1. HVAC Duct Construction Standards, Metal and Flexible, 2nd Edition, 1995, for rectangular and round ductwork up to positive 10" WG (2500 Pa) and negative 10" WG (2500 Pa) and flat oval ductwork up to positive 10" WG (2500 Pa).
 - a. Internal tie rods or bracing are not allowed for ductwork 40" (1016 mm) and smaller. Tie rods shall be 1/2" (13 mm) or 3/4" (19mm), galvanized steel EMT/conduits with bolt assembly consisting of rubber washer and friction anchored threaded insert similar to Ductmate Easyrod or PPI Condu-Lock.
 - b. Internal tie rods are not allowed for welded ductwork and special exhaust systems, such as fume hood exhaust.
 - 2. Round Industrial Duct Construction Standards, 2nd Printing 1999.

1.06 WELDING REQUIREMENTS

- A. The following requirements cover arc and braze welding of nonstructural sheet metal ductwork for HVAC, architectural metal and other FDA process applications where pressures do not exceed 120" WG (30 kPa) (positive or negative). These requirements also apply to welding of structural members whose sole purpose is stiffening, supporting, or reinforcing of sheet metal material, as well as attachment of brackets or other accessories/components required to provide complete systems.
- B. Procedure and Qualification:
 - 1. Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) shall be prepared by installing contractor and/or fabricator prior to execution of related work. Qualification of welding procedure shall meet or exceed requirements of the latest revision of American Welding Society, Sheet Metal Welding Code ANSI/AWS D9.1.
 - 2. Provide certification of satisfactory performance testing for all welders and welding operators, which provide welding services on Project.
 - 3. Establish and provide written quality control (QC) procedures to ensure compliance with specification requirements. Clearly identify appropriate steps for safe welding procedures (review Appendix J of D9.1) including additional safety material, screens, eye, personnel and clothing protection, fire suppression equipment, and fume extraction equipment needed adjacent to welding work area.

PART 2 - PRODUCTS

2.01 GALVANIZED STEEL SHEET

- A. First quality, Lock Former Quality (LFQ), cold rolled, open hearth soft steel sheet capable of double seaming without fracture, ASTM A924 or ASTM A653. Galvanized coating shall be G90.
- B. Use G90 Galvaneal or Zincgrip where painting is specified.

2.02 STAINLESS STEEL SHEET

- A. First quality, cold rolled annealed, pickled, ASTM A240 and A480, Finish No. 2B for concealed work and Finish No. 4 for exposed work. Unless otherwise indicated, use Type 304L where welded duct construction is specified and Type 304 where non-welded duct construction is allowed.

2.03 NON-METALLIC FLEXIBLE DUCT

- A. Manufacturers: Thermaflex, Casco, or Flexmaster, similar to Thermaflex Model M-KE or Flexmaster Type 6
- B. Factory fabricated, UL listed under UL-181 as Class 1 duct, meeting requirements of NFPA 90A with flame spread of 25 or less and smoke developed rating of 50 or under.
- C. Flexible duct shall be suitable for:
 - 1. Operating Temperature: -20° (-29°C) to 250°F (121°C)
 - 2. Operating Pressure:
 - +10" WG (2500 Pa) (4-12" (100-300 mm) ID)
 - +6" WG (1500 Pa) (14-16" (350-400 mm) ID)
 - +4" WG (1000 Pa) (18-20" (460-500 mm) ID)
 - 1" WG (-250 Pa) (4-12" (100-300 mm) ID)
 - 0.5" WG (-125 Pa) (14-20" (350-500 mm) ID)
 - 3. Velocity: 5000 fpm (1524 mpm)
- D. Unless otherwise indicated, duct shall be nonmetallic insulated type composed of polyester film, polyethylene film, nylon film or coated woven fiberglass liner bonded permanently to corrosion resistant coated steel wire helix.
- E. Insulation shall be minimum R6.0 fiberglass insulation blanket with maximum thermal conductance of 0.23 K at 75°F (24°C). Vapor barrier jacket shall be aluminum foil reinforced, polyethylene, or metalized polyester film with minimum perm rating of 0.05 perm.
- F. Insulation material shall not be exposed to air stream.
- G. Lined flexible duct shall have the following minimum acoustical performance in accordance with ARI Standard 885. Dynamic Insertion Loss in each octave band of 5 ft or 10 ft straight duct shall not be less than the following:

<u>Duct Diameter</u> <u>(in./mm)</u>	<u>Dynamic Insertion Loss (dB)</u>					
	<u>Octave Band Center Frequency (Hz)</u>					
	<u>(Based on 5 ft (1.5 m) length)</u>					
	<u>125</u>	<u>250</u>	<u>500</u>	<u>1000</u>	<u>2000</u>	<u>4000</u>
6 / 150	6	9	18	22	24	15
8 / 200	6	10	18	20	21	12
10 / 250	5	11	18	18	18	9

<u>Duct Diameter</u> <u>(in./mm)</u>	<u>(Based on 10 ft (3 m) length)</u>					
	<u>125</u>	<u>250</u>	<u>500</u>	<u>1000</u>	<u>2000</u>	<u>4000</u>
6 / 150	10	15	28	33	35	22
8 / 200	10	18	29	32	32	20
10 / 250	9	19	28	31	29	18

2.04 METALLIC FLEXIBLE DUCT

- A. Manufacturers: Flexmaster Triple Lock Aluminum or approved equal.
- B. Construction:
- C. All aluminum construction with a thermal conductance (C-factor) of not more than 0.23.
- D. Factory fabricated, UL listed under UL-181 as Class 1 duct, meeting requirements of NFPA 90A with flame spread of 25 or less and smoke developed rating of 50 or under.
- E. Flexible duct shall be suitable for pressures and temperatures involved, but not less than 250°F service temperature, 12" WG positive, min. 8" WG negative pressure rating, and velocity rating of 5500 fpm. All tests shall be performed according to Air Diffusion Council Flexible Air Duct Test Code FD72 R1.
- F. Insulation shall be fiberglass with R value of at least 4.2 at a mean temperature of 75°F.
- G. Insulation material shall not be exposed to air stream.

2.05 MANUFACTURED ROUND OR FLAT OVAL DUCTWORK (POSITIVE PRESSURE)

- A. Single Wall:
 - 1. Manufacturers: Ajax, Lindab, Semco or United McGill, equal to United McGill Uni-Seal duct and fittings suitable to positive 10" WG (2500 Pa).
 - 2. Ducts shall be machine formed round and/or flat oval as shown on drawings, constructed of G90 galvanized steel. Use spiral lockseam construction. Longitudinal seam construction may be used for ductwork over 80" (2032 mm) diameter with minimum 16 ga (1.6 mm). Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.
 - 3. Unless otherwise indicated, connection shall be slip type with minimum 2" (50 mm) insertion length or flanged joint in accordance with manufacturer's recommendations. When flange joints are required, use Van Stone angle rings welded to duct.
 - 4. Internal bracing is not allowed.
- B. Double Wall (insulated):
 - 1. Manufacturers: Lindab, Semco or McGill AirFlow duct and fittings suitable to positive 10" WG.
 - 2. Ducts shall be machine formed round and flat oval as shown on drawings, constructed of G90 galvanized steel. Use spiral lockseam construction. Inner liner shall be perforated or solid as indicated, and annular space shall be filled with 1" thick fiberglass insulation. Use fittings with solid liner as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.
 - 3. Unless otherwise indicated, connection shall be slip type connection with minimum 2" insertion length or flanged joint in accordance with manufacturer's recommendations. When flange joints are required, use Van Stone angle rings welded to duct.
 - 4. Internal bracing is not allowed.

2.06 MANUFACTURED ROUND DUCTWORK (NEGATIVE PRESSURE)

- A. Manufacturers: United McGill Industrial duct and fittings. Semco and Lindab are acceptable manufacturers, provided meeting requirements in this Section.
- B. Ducts shall be machine formed round duct constructed of G90 galvanized steel. Use spiral lockseam construction unless otherwise indicated. Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.
- C. Connection shall use slip coupling, angle ring or Van Stone connectors in accordance with manufacturer's recommendations.
- D. Fitting gauge shall be one even gauge heavier than the lightest allowable gauge of connecting downstream section of duct.

2.07 DUCT SEALANT AND GASKET

- A. Sealant:

1. UL Classified sealant as compounded specifically for sealing joints and seams in ductwork. Hardcast, United McGill, Ductmate, Mon-Eco Industries or H.B. Fuller/Foster. Duct tapes are not allowed.
 2. Select sealants as recommended by manufacturer for specific application.
 3. Submit sealant manufacturer's data sheets including performance data, pressure ratings, surface burning characteristics data, detailed installation instructions.
- B. Gaskets:
1. Butyl, copolymer or neoprene based tape similar to Ductmate 440 Gasket Tape or Neoprene Gasket Tape for flanged joints.
- C. Duct Sealant and Gaskets for Fume Hood Exhaust Ductwork:
1. Sealant shall be similar to Hardcast Sure-Grip 404 Ductmate Proseal.
 2. Gasket material shall be Teflon based similar to Gore-Tex Series 300.
 3. Gasket thickness and width shall be as required for flange and surface irregularities to seal joint air tight.

2.08 CABLE SUSPENSION SYSTEM

- A. Cable Suspension systems are not allowed.

PART 3 - PRODUCTS

3.01 GENERAL

- A. Install ductwork parallel to building walls and ceilings and at such heights not to obstruct any portion of ceiling, window, doorway, stairway, or passageway. Install ductwork to allow adequate access and service space for equipment. Refer to drawings and/or manufacturer's recommendations. Install vertical ductwork plumb. Where interferences develop in field, offset or reroute ductwork as required to clear such interferences. In all cases, consult drawings for exact location of duct spaces, ceiling heights, door and window openings or other architectural details before installing ductwork.
- B. Make allowances for beams, pipes or other obstructions in building construction and for work of other contractors. Check plans showing work of other trades and consult with Engineer in event of interference. Transform, divide, or offset ducts as required, in such a manner as to maintain same cross sectional area of duct as indicated on drawings. Where it is necessary to install pipes or similar obstructions through ducts, consult with Engineer and obtain written approval from Engineer and Owner. If approved, provide streamlined encasement or collar designed in accordance with SMACNA Standards and seal to prevent air leakage.
- C. Ductwork shall be free of kinks and dents.
- D. Fabricate and install duct, fittings, joints, seams, reinforcement, supports, sealing, liner, etc., in sizes indicated on drawings and in accordance with manufacturer's published data and SMACNA Standards except as modified in this Section of Specifications.
- E. Provide transitions where different size or different shape ductwork segments are connected. Use concentric transitions unless otherwise shown. Unless otherwise indicated, make diverging transitions with maximum angle of 15° per side (30° total diverging) and converging transitions with maximum angle of 25° per side (50° total converging).
- F. Provide transitions at ductwork system components and connections to equipment. Refer to Specification Section 23 3713 – Diffusers, Registers, and Grilles, for additional information regarding diffuser/register/grille connections.
- G. Refer to ductwork symbols list on drawings for additional and dimensional requirements for fittings.
- H. Seal duct seams and joints to meet SMACNA Class A as minimum for all ductwork including low-pressure ductwork.
- I. Construct ductwork so that interior surfaces are smooth. Internal duct hangers and internal bracing are not allowed. Refer to Part 1, Design Criteria for internal tie rods.

- J. Support coils, filters, air terminals, dampers or other devices installed in duct systems with angles or channels, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets, nuts, bolts and washers.
- K. Air terminal devices may be supported by strap hangers if air terminal manufacturer approves. Strap hangers are not allowed for fan powered devices, double wall type and Titus Steri-Loc type devices.
- L. Install outside air intake duct to pitch down at minimum 1" (25 mm) per 20 ft (6 m) toward intake louver or plenum and to drain to outside of building. Solder or seal seams to form watertight joints.
- M. Install exhaust air duct to pitch down at minimum 1" (25 mm) per 20 ft (6 m) toward exhaust louver.
- N. Blank off unused portion of outside air intake or exhaust louvers.
- O. Where 2 different metal ducts meet, install joint in such a manner that metal ducts do not contact each other by using proper gasket seal or compound.
- P. Install motor operated dampers and connect to or install equipment furnished by others. Provide necessary blank-off plates or transitions to mount control dampers as specified in Section 23 0901 - Control Systems Integration.
- Q. Do not install ductwork over electrical panelboards, switchgear, switchboards or motor control centers.
- R. When original galvanized finish is altered or damaged, apply field galvanizing paint as follows:
 - 1. Prepare surface with use of power sanders or wire brushes to remove rust, paint, etc.
 - 2. Apply cold galvanizing material equal to ZRC Products, Inc.

3.02 ELBOWS

- A. Rectangular Duct:
 - 1. Unless specific type is indicated, use radius elbows with minimum centerline radius to width or diameter ratio of 1.5. Where 1.5 radius elbows do not fit, use the following elbows:
 - a. Supply Air Ductwork:
 - 1) 1.0 radius elbows
 - 2) Square throat elbows with turning vanes where 1.0 radius elbows do not fit
 - b. Return or Exhaust Air Ductwork:
 - 1) 1.0 radius elbows with full splitter vanes (SMACNA Type RE3) as follows:
 - a) One vane for duct width 24" (610 mm) to 48" (1220 mm)
 - b) Two vanes for duct width 49" (1245 mm) to 72" (1830 mm)
 - c) Three vanes for duct width 73" (1850 mm) and larger
 - d) Fabricate vanes in accordance with SMACNA HVAC Duct Construction Standard, chart 4-1(p 4.11) and Figure 4-9 (p 4.13).
 - 2) 45° throat with radius heel elbows with full splitter vanes as follows where 1.0 radius elbows do not fit:
 - a) One vane for duct width 12" (305 mm) to 24" (610 mm)
 - b) Two vanes for duct width 25" (635 mm) to 36" (914 mm)
 - c) Three vanes for duct width 36" (914 mm) and larger
 - d) Fabricate vanes in accordance with SMACNA HVAC Duct Construction Standards, Chart 4-1 and Figure 4-9.
 - 3) Square throat - radius heel elbows or square throat elbows with turning vanes are not allowed unless specifically indicated.
- B. Round and Oval Duct:
 - 1. Unless specific type is indicated, use radius elbows with centerline radius to diameter ratio of 1.5. Where 1.5 radius elbows do not fit, use 1.0 radius elbows.

3.03 LONGITUDINAL SEAM

- A. Rectangular Duct:

1. Unless otherwise indicated, use Pittsburgh lock seam for rectangular ductwork.
 2. Button punch snap lock construction (SMACNA L-2) may be used for ductwork for 2" WG (500 Pa) (+ or -) and lower, and sizes 48" (1220 mm) and smaller in width. All snap lock seams are to be secured with self-drilling screws at each end of the duct segment.
 3. Button punch snap lock construction is not allowed for ductwork in chases and areas above inaccessible ceiling.
 4. Button punch snap lock construction is not allowed on aluminum ductwork.
- B. Round and Oval Duct:
1. Unless otherwise indicated, longitudinal seams shall be in accordance with SMACNA HVAC Duct Construction Standards. Snaplock seams are not allowed.

3.04 TRANSVERSE JOINT

- A. Rectangular Duct:
1. Transverse joints shall be in accordance with SMACNA HVAC Duct Construction Standards.
 2. Ductmate 25/35 connection systems with corner clips or optional nuts and bolts may be used. Incorporate use of all Ductmate accessories to ensure integrity of transverse connection. Install joints in strict accordance with the latest edition of Ductmate 25/35 Assembly and Installation Instruction Manual and Duct Construction Standards. Nexus or WDCI will be acceptable.
 3. Lockformers TDC or Engles TDF may be used in accordance with T-25 flanges of SMACNA HVAC Duct Construction Standards, Metal and Flexible, Second Edition, 1995, provided that corner pieces with bolts are used. If TDF/TDC flanges are damaged, replace the damaged joint(s) by straightening and reinforcing with minimum 1-1/2" x 1-1/2" x 1/4" (40 mm x 40 mm x 6.5 mm) angle at each side of transverse joint.
- B. Round and Flat Oval Duct:
1. Unless otherwise indicated, use beaded sleeve joints (SMACNA RT-1) with minimum 2" (50 mm) insertion length or flange joints (SMACNA RT-2 or RT-2A).
 2. Connection systems manufactured by Ductmate Industries (Spiralmate and Ovalmate) may be used for supply air ductwork.
 3. AccuFlange connected systems may be used with gaskets specified in Part 2 of this Section.

3.05 DUCT SUPPORTS

- A. Unless otherwise indicated, use straps or Z bar hangers with 3/8" (9.5 mm) rods to support rectangular ducts 60" (1524 mm) wide and smaller and trapeze hangers with rods or angles to support rectangular ducts over 60" (1524 mm) wide.
- B. Use trapeze hangers to support externally insulated ductwork with weight bearing inserts. Refer to Section 20 0700 – Mechanical Systems Insulation and details.
- C. For round ducts 24" (610 mm) diameter or smaller, use single hanger.
1. Round Duct Strap Bracket by Ductmate Industries may be used up to 24" (610 mm) diameter.
- D. For round ducts 25" (635 mm) diameter or larger, use 2 minimum 3/8" (9.5 mm) rods, with trapeze in accordance with the following schedule:

<u>Duct Size</u>	<u>Trapeze (Half Round)</u>
25" (635 mm) through 36" (914 mm)	1-1/2" x 1-1/2" x 1/8" (40 mm x 40 mm x 3 mm)
37" (940 mm) through 48" (1220 mm)	1-1/2" x 1-1/2" x 1/4" (40 mm x 40 mm x 6.5 mm) or 2" x 2" x 1/8" (50 mm x 50 mm x 3 mm)

<u>Duct Size</u>	<u>Trapeze (Half Round)</u>
49" (1245 mm) through 60" (1524 mm)	2" x 2" x 1/4" (50 mm x 50 mm x 6.5 mm)
61" (1550 mm) through 84" (2133 mm)	2-1/2" x 2-1/2" x 1/4" (63 mm x 63 mm x 6.5 mm)

- E. Refer to Section 20 0700 - Mechanical Systems Insulation for ductwork insulation, weight bearing inserts and insulation protection shield requirements.
- F. Support vertical ducts at every floor.
- G. The following upper attachments, upper attachment devices, lower hanger attachments, hanger devices, and/or hanger attachments are not allowed except where specifically indicated:
 - 1. Hook or loop
 - 2. Nailed pin fasteners
 - 3. Expansion nails without washers
 - 4. Powder charged or mechanically driven fasteners (forced entry anchors)
 - 5. Cable Support systems
 - 6. Beam or "C" clamps without retaining clips or friction clamps (provide retaining clips for "C" clamps)
 - 7. Friction clamps for ductwork over 12" (305 mm)
 - 8. Non-factory manufactured upper attachments for metal pan deck including wire coil and double circle (Items 16 and 17 of Fig 4-3 of SMACNA HVAC Duct Construction Standards 95)
 - 9. Wire hanger
 - 10. Trapeze hangers supported by wires or straps
 - 11. Rods, straps or welded studs directly attached to metal deck
 - 12. Drilled hole with attachment to structural steel
 - 13. Lag screw expansion anchor
 - 14. Rivets
- H. Supporting devices shall be standard products of manufacturers having published load ratings.
- I. Refer to Section 20 0529 - Mechanical Supporting Devices for additional support requirements including attachments to structures.
- J. For welded ducts, soldered ducts or ducts with water tight joints, do not use supports utilizing screws or other penetrations into ductwork.
- K. Unless Architectural Documents indicate the required framing, provide angle iron framing around roof opening where duct penetrates through roof decking, to maintain roof decking structural integrity in accordance with roof decking manufacturer's recommendations. This is not required for concrete decking. For concrete decking, consult with the project structural engineer for location and size of opening prior to execution of Work.

3.06 SHEET METAL WELDING

- A. Welded ductwork shall be butt-welded unless otherwise indicated. Backing material and slip joints are not allowed.
- B. Attach welding cable leads directly to base metal to be welded. Do not jumper welding cable leads through building structure, to avoid emission of stray voltage/current through building structure.
- C. Welds on exposed ductwork in occupied spaces shall be brush polished with stainless steel brush.
- D. Welds at exterior of building shall be ground smooth and brush polished with stainless steel brush to prevent atmospheric contamination and rust formation.

3.07 PROTECTION OF DUCTWORK

- A. Protect ductwork during construction against entry of foreign matter and construction dirt.

- B. Keep ductwork capped when work is complete for the day or when duct is not being worked on or added to. Use of polyvinyl (VISQUEEN) with duct tape wrap is an adequate measure as long as it is secure with no openings or tears in product.
- C. If ductwork is not protected, remove dirt and foreign matter from the duct system and obtain inspection and approval from Engineer upon completion of cleaning before operating fans.

3.08 DUCT LEAKAGE TEST

- A. Refer to Test and Balancing portion of Section 20 0000 - General Mechanical Requirements.
- B. Owner and/or Owner's representative may elect to witness leakage tests. Notify Owner and/or Owner's representative at least 3 days in advance.
- C. Leakage test procedures shall be in accordance with test method described in Section 3 of SMACNA HVAC Air Duct Leakage Test Manual, except as modified in this Section. Test apparatus shall be in accordance with Section 5 of SMACNA HVAC Air Duct Leakage Test Manual.
- D. Test pressure shall be equal to duct pressure class. Negative pressure ductwork shall be tested with negative test pressure.
- E. Air leakage shall not exceed limits specified. If leakage exceeds allowable limits, identify leaked areas, repair, seal and retest.
- F. Provide filter system on duct inlet to test blower. Filter system shall be equal to final filtering efficiency of AHU supply air duct system. Filters are not required for negative pressure testing.
- G. Do not insulate ductwork until it has been successfully tested.
- H. Ductwork systems to be tested and maximum permitted leakage of ductwork systems are as indicated on schedules on drawings.
- I. Welded ductwork shall be air and watertight and shall have no air leakage with allowance stated below.
 - 1. When using test apparatus and procedure described in SMACNA HVAC Air Duct Leakage Test Manual, 1st Edition, Chapter 5 (modified for negative pressure), the following losses can be expected during testing and are acceptable:
 - a. 1 cfm (0.03 m³/min) per 1" WG (250 Pa) of static pressure is allowed for the test equipment and test connections (e.g. 3 CFM when testing at 3" WG (750 Pa)).
 - b. 0.10 (0.003 m³/min) cfm per inch of diameter of temporary caps, regardless of pressure (e.g. 1 cfm (0.03 m³/min) for a cap on 10" (250 mm) diameter duct).
 - 2. To the extent possible, walk and observe welded ductwork under test to check for cracked or hissing welds. All leaks in welded sections of ductwork shall be reported to the Client's Representative and repaired by welding. No caulking or sealing is allowed.

3.09 LOW PRESSURE DUCT CONSTRUCTION (PRESSURE CLASS 2" WG AND UNDER)

- A. Use welds, rivets or nuts, and bolts for fabricating ductwork. Fully threaded sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if screw does not extend more than 1/2" (13 mm) into duct. Sheet metal "TEK" screws 3/4" (19 mm) in length may be used as fasteners in conjunction with factory made transverse joints.
- B. Unless otherwise indicated, construct branch take-off fittings as follows:
 - 1. For branch take-offs including branch ducts serving more than one diffuser or grille, use 45° entry fittings. For supply air ducts, expanded or conical taps may be used.
 - 2. For take-offs serving single diffuser, register or grille, use straight spin-in collars with manual balancing dampers.
- C. Do not use splitter dampers and/or extractors unless manual volume dampers alone do not accomplish the intended balancing. Obtain Engineer's written approval before installing them. Use of splitter dampers and/or extractors will not eliminate need for specified or indicated manual volume dampers.

3.010 HIGH PRESSURE DUCT CONSTRUCTION (PRESSURE CLASS 3" WG AND OVER)

- A. Use manufactured ductwork or Contractor fabricated ductwork meeting specified Construction Standards.
- B. Submit construction details including materials, type of service, reinforcing methods, and sealing procedures.
- C. Use elbows, tees, laterals, crosses and accessory fittings as shown on drawings and as required to fabricate duct system.
- D. Use expanded or conical tees for branch take-offs from mains.
- E. Provide manufactured bellmouth fittings at each fan supply air plenum to provide smooth entrance of air into duct system.
- F. Provide positive pressure relief doors as indicated on drawings.
- G. Provide negative pressure relief doors as indicated on drawings.
- H. Ductwork pressure class is indicated on drawings.

3.011 NON-METALLIC FLEXIBLE DUCT

- A. Non-metallic flexible duct shall not be used in exhaust systems.
- B. Install flexible ducts in accordance with manufacturer's installation instructions and SMACNA Standards, except as modified in this Section of Specifications.
- C. In supply air systems without air terminal devices, used flexible ducts for final connections to diffusers, grilles, and registers. Flexible ducts shall be minimum 4 ft long and maximum 6 ft long.
- D. In supply air systems with air terminal devices, use flexible ducts for duct connections to diffusers, grilles, and registers for sound attenuation purposes, except above non-accessible ceilings. Flexible ducts shall be minimum 4 ft long and maximum 6 ft long.
- E. In return air systems without air terminal devices, flexible ducts may be used for final connections to return grille plenum boxes, grilles, and registers. Flexible ducts shall be minimum 4 ft long and maximum 6 ft long.
- F. In return air systems with air terminal devices, flexible ducts shall be used for duct connections to return grille plenum boxes and registers for sound attenuation purposed, except above non-accessible ceilings. Flexible ducts shall be minimum 4 ft long and maximum 6 ft long.
- G. Centerline radius of bends shall not be less than 1 1/2 duct diameters.
- H. Support flexible ductwork at a maximum of 3 ft on center and at elbow, with no portion lying on ceiling supporting system.
- I. Individual sections of flexible ductwork shall be of one-piece construction. Splicing of short sections is not allowed.
- J. Connect flexible duct liner to collars with draw bands. If collars have beads, position draw-bands behind beads.
- K. Pull insulation and vapor barrier jacket over liner connection and secure with draw band. For terminations at externally insulated ductwork, fittings, grilles, diffusers, etc., secure flexible duct jacket to ductwork insulation jacket with compatible vapor barrier tape.
- L. Flexible ducts are not allowed above non-accessible ceilings.
- M. Flexible ducts are not allowed in high pressure ductwork.
- N. Flexible ducts are not allowed to pass through any partition, wall, floor or ceiling.

3.012 METALLIC FLEXIBLE DUCT (GENERAL EXHAUST).

- A. Install metallic flexible duct as specified below.
- B. Install metallic flexible ducts in accordance with manufacturer's installation instructions and SMACNA Standards, except as modified in this Section of specifications.
- C. Metallic flexible ducts shall be used for final connections to general exhaust grille plenum boxes, grilles and registers except as noted otherwise. Flexible ducts shall be minimum 4 ft long and maximum 6 ft long.
- D. Metallic flexible ducts for ducts used in exhaust systems require insulation if the remainder if the duct system is to be insulated.
- E. Metallic flexible ducts are not allowed to pass through any partition, wall, floor or ceiling.

- F. Centerline radius of bends shall not be less than 1 1/2 duct diameters.
- G. Support metallic flexible ductwork at a maximum of 3 ft on center with no portion lying on ceiling supporting system.
- H. Individual sections of flexible ductwork shall be of one piece construction. Splicing of short sections is not allowed.
- I. Metallic flexible ducts are not allowed in high pressure ductwork.

3.013 FUME EXHAUST DUCT CONSTRUCTION

- A. General:
 - 1. Construct elbows with centerline radius to width or diameter ratio of at least 1.5 and 45° lateral branch take-offs from mains.
- B. Ductwork pressure class is indicated on drawings.
- C. Stainless Steel Ducts:
 - 1. Use 18 ga or heavier stainless steel sheet with all joints and seams butt-welded airtight.
 - 2. Use longitudinal seam construction with seam at top on horizontal runs. Spiral seams are not allowed on round duct. Square and mitered elbows are not allowed.
 - 3. Grind and polish smooth all interior joints.

3.014 STERILIZER EXHAUST DUCT CONSTRUCTION

- A. Use 18 ga (1.3 mm) or heavier stainless steel sheet with all joints and seams welded watertight. Butt-weld all joints.
- B. Use longitudinal seam construction with seam at top on horizontal runs.
- C. Spiral seams will not be acceptable on round duct.
- D. Install ductwork without forming dips, sag or traps, which might collect liquid. Pitch horizontal branch ducts at minimum 1/4" per foot, starting at the connection to the main duct down toward exhaust grilles.

END OF SECTION

**SECTION 23 3314
DUCTWORK SPECIALTIES**

PART 1 - GENERAL

1.01 SUMMARY

- A. This section includes ductwork specialties for systems shown in Contract Documents, except where provide by equipment manufacturer.

1.02 RELATED WORK

- A. Section 23 3114 - Ductwork

1.03 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.04 SUBMITTALS

- A. Shop Drawings including, but not limited to, the following:
1. Manufacturer's name and model number
 2. Capacities
 3. Temperature/pressure ratings
 4. Materials of construction
 5. Dimensions
 6. Manufacturer's installation instructions and/or detailed drawings
 7. All other appropriate data

1.05 DESIGN CRITERIA

- A. Products and materials shall conform to NFPA Section 90A, possessing flame spread rating of not over 25 and smoke developed rating no higher than 50.
- B. Ductwork specialties exposed to air stream, such as dampers, turning vanes and access doors, shall be of same material as duct at where the specialties are mounted, unless otherwise noted.
- C. Unless otherwise noted, ductwork specialties shall be designed and manufactured to conform to same pressure class as ductwork in which they are installed.

PART 2 - PRODUCTS

2.01 MANUAL BALANCING DAMPERS

- A. Manufacturers: Ruskin, Vent Products or Air Balance, constructed in accordance with SMACNA HVAC Duct Construction Standards, except as modified below.
- B. Rectangular Dampers:
1. For low pressure ductwork, for damper blade height up to 12" (300 mm), use single blade type with minimum 22 ga (0.8 mm) galvanized steel blade with minimum 3/8" (9.5 mm) rod for blade width up to 18" (460 mm), and with minimum 18 ga (1.3 mm) galvanized steel blade with minimum 1/2" (13 mm) continuous rod for blade width from 19" (480 mm) to 48" (1220 mm). For damper blade height more than 12" (300 mm), use multiple blade type with minimum 16 ga (1.6 mm) galvanized steel channel frames, opposed blade linkage operation, with blades minimum 16 ga (1.6 mm) and 6" (150 mm) to 8" (200 mm) maximum blade width, minimum 1/2" (13 mm) continuous rod and 1/2" x 1/2" (13 mm x 13 mm) galvanized steel angle blade stops. Bearings shall be nylon or molded synthetic. Construct dampers over 48" (1220 mm) in width or height in multiple sections with mullions.
 2. For high pressure ductwork, dampers shall be constructed to withstand maximum pressure of 5 inches WG (1250 Pa) at closed position and maximum velocity of 2000 fpm (610 m/min) at open position. Frame and blades shall be constructed of minimum 16 ga (1.6 mm) with minimum 1/2" (13 mm) diameter or square rod.
- C. Single Blade Round Damper

1. For low pressure ductwork, damper shall have blade 24 ga (0.6 mm), but no less than two gauges more than duct gauge. Rod shall be minimum 3/8" (9.5 mm) diameter or square continuous. Bearings shall be nylon or molded synthetic.
 2. For high pressure ductwork, damper blade shall be minimum 16 ga (1.6 mm). Rod shall be minimum 1/2" (13 mm) square continuous and tack welded to blade. Provide sealed end bearing similar to Ventlok #609 and acorn nut type dial regulator similar to Ventlok #635 or 641.
- D. Provide damper operators with locking devices and damper position indicators. Sheet metal screws are not allowed in construction or installation of dampers. Use rivets or tack welds.
- E. Dampers shall be properly stiffened and fabricated to prevent vibration, flutter or other noise.
- F. Extend damper shafts through duct insulation or use elevated regulators for externally insulated ducts to accommodate specified insulation thickness.

2.02 TURNING VANES

- A. Construct turning vanes in accordance with SMACNA HVAC Duct Construction Standards.
- B. Square Throat Elbow Turning Vanes (Vane Runner Length up to 18" (460 mm) and Vane Length up to 36" (914 mm)):
1. Use single thickness vanes having 2" (50 mm) radius and 1-1/2" (40 mm) spacing, 24 ga (0.6 mm) minimum. Construct vanes in accordance with SMACNA HVAC Duct Construction Standards.
- C. Square Throat Elbow Turning Vanes (Vane Runner Length over 18" (460 mm) or Vane Length over 36" (914 mm)):
1. Use double thickness vanes having 4.5" (114 mm) radius and 3.25" (82.55 mm) spacing, 22 ga (0.8 mm) minimum.
- D. Radius Elbow Splitter Vanes:
1. Splitter vanes for radius elbows shall be extended entire length of fitting and constructed in accordance with SMACNA HVAC Duct Construction Standards.

2.03 BACKDRAFT DAMPERS

- A. Manufacturers: Ruskin, Greenheck
- B. Dampers shall be multi-blade, weighted type with counter-balanced blades and with 12 ga galvanized steel frame and extruded aluminum airfoil-shaped blades equal to Ruskin Type CBS 92. Blade edges shall have silicon rubber seals with ball bearings. Dampers shall be suitable for flange and gasket connection to ductwork or fan outlet.
- C. Dampers shall be rated to maximum velocity of 4000 fpm (1220 m/min), maximum temperature of 250°F (120°C) and maximum system pressure of 5" WG (1250 Pa) for damper width of 60" (1524 mm) and 14" WG (3500 Pa) for damper width of 12" (605 mm).
- D. Maximum damper leakage shall be 13.5 cfm/sf based on pressure differential of 1" WG (250 Pa).

2.04 FIRE DAMPERS

- A. Manufacturers: Air Balance, Prefco, Greenheck, Nailor, Cesco, Pottorff Louvers and Dampers, or Ruskin
- B. Fire damper assemblies shall be listed by UL with 165°F (74°C) fusible link and shall meet construction standards as set forth in NFPA 90A.
- C. Dampers shall be dynamic type dampers rated to minimum 2000 fpm (610 m/min) and 4" WG (1000 Pa).
- D. Dampers shall be curtain type with blades out of air stream when in open position. Where curtain type dampers are not available because of size, use multiple blade type dampers.
- E. For round ducts, dampers equal to Ruskin Model FDR25 may be used.
- F. Damper fire rating shall be compatible with rating of building surface in which damper is used.
- G. Submit UL installation details to showing mounting method and duct connection method.

- H. Where ceiling fire dampers are used, they are to be equal to Ruskin CFD(R) 2 or 3, UL Classified for installation in fire rated floor or roof/ceiling assemblies.

2.05 ACCESS DOORS

- A. Access doors shall be rectangular, minimum 22 ga (0.8 mm) frame and minimum 24 ga (0.6 mm) door, fit air tight with gasket and shall be suitable for duct pressure class. Doors shall be double-wall, insulated when installed in insulated ductwork or unit casing and located for greatest ease of access. Access doors constructed with sheet metal screw fasteners are not acceptable.
- B. Low Pressure Ducts (Pressure Class 2" (50 mm) and Under):
 - 1. Doors shall be hinged type with sash lock for exposed application and non-hinged type with cam latches for concealed application.
 - 2. Access doors constructed in accordance with SMACNA HVAC Duct Construction Standard (Figure 7-2) or similar to Ruskin Model ADC or ADH will be acceptable.
 - 3. Sandwich style access doors made by Ductmate, Ward Industries, or Flexmaster are acceptable, provided that they meet insulation requirements and include edge protection.
- C. High Pressure Ducts (Pressure Class 3" (75 mm) and Over):
 - 1. Use access doors factory fabricated and rated by manufacturer's published literature for installation in systems with pressures to positive or negative 10" WG (2500 Pa).
 - 2. Sandwich access doors made by Ductmate, Ward Industries, or Flexmaster are acceptable, provided that they meet insulation requirements and include edge protection.

2.06 DUCT FLEXIBLE CONNECTIONS

- A. Manufacturers: Unless specifically indicated, Ventfabrics, Inc. or Duro Dyne, equal to Duro Dyne model indicated. Material shall be glass fabric, fire retardant, waterproof, air tight and comply with UL Standard 214 and NFPA 90A.
- B. General Supply, Return and Exhaust Ductwork:
 - 1. Material for indoor use to be 30 oz per square yard, double coated with neoprene, suitable for -40 to 200°F (-40 to 93°C) continuous operation similar to Duro Dyne Neoprene.
 - 2. Material for outdoor use shall be combination of inner layer of Duro Dyne Neoprene and outer layer of 24 oz per yard, coated with Hypalon, UV resistant, suitable for -40°F up to 250°F (-40 to 120°C), similar to Duro Dyne Durolon.
- C. Special Exhaust Ductwork:
 - 1. Material for indoor use shall be 17 oz per yard, teflon or silicon coated, suitable for -65 to 500°F (-54 to 260°C), similar to Duro Dyne Thermafab.
 - 2. Material for outdoor use shall be combination of inner layer of Thermafab and outer layer of Durolon.

2.07 SOUND ATTENUATING DEVICES

- A. Manufacturers: Industrial Acoustics Company, Semco, Aerosonics, United McGill, Aeroacoustic, Vibro-Acoustics, Ruskin Sound, or Dynasonics
- B. Units shall be tested in accordance with ASTM E-477-99 silencer test standard in aero-acoustic test facility which is NVLAP accredited for ASTM E-477-99 Standard. Each test shall have been conducted within last 12 month period. Submit copy of laboratory's NVLAP accreditation certificate on dynamic insertion loss, self-noise power levels, and aerodynamic performance.
- C. Outer casing of units shall be not less than 22 ga (0.8 mm) G90 galvanized steel in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork for 8" WG (2 kPa) or pressure class indicated for duct system, if it is higher than 8" WG (2 kPa). Seams shall be lock formed or continuously welded and mastic filled.
- D. Acoustic Materials:
 - 1. Media shall be long fiber fiberglass protected with covering material and lined with not less than 26 ga (0.5 mm) galvanized perforated steel. Filler and facing material shall meet

requirements of NFPA 90A with flame spread rating of 25 or less, and smoke development rating of 50 or less.

- E. Covering Materials:
 - 1. Covering material shall be Tedlar or Mylar film.
- F. Ends of attenuators shall be covered at factory with plastic, heavy-duty paper, cardboard, or other appropriate material to prevent entrance of dirt, water, or any other foreign matter to inside of attenuators. Caps shall not be removed until attenuator is installed in duct system.
- G. Unless otherwise indicated, sound attenuating devices shall meet acoustical performance requirements as scheduled in each octave band frequency under the flow conditions.
- H. Sound Attenuating Devices for Fume Hood Exhaust Fans:
 - 1. Similar to IAC Model KM.
 - 2. Provide units at exhaust fan intakes and discharges as scheduled. Unit length shall be as scheduled.
 - 3. Rectangular type constructed entirely of Type 304 stainless steel, in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork. Seams shall be welded. Units shall contain no sound absorptive material. Attenuation shall be accomplished by, controlled impedance membranes and broadly tuned resonators. Units shall not fail structurally when subjected to differential air pressure of 8" WG (2 kPa) inside to outside of casing.

2.08 REMOTE OPERATED VOLUME CONTROL DAMPERS

- A. Young Regulator Co. or Metropolitan Air Technology similar to Young Regulator Model 830 dampers, furnished with Bowden 270-275 remote cable controls.

2.09 INSTRUMENT TEST HOLES

- A. Manufacturers: Ventlok 699 (up to 1" (25 mm) insulation thickness) or Ventlok 699-2 (over 1" (25 mm) insulation thickness).
- B. Use concave gaskets for round ductwork.

2.010 CONTROL DAMPERS

- A. Refer to Section 25 3523.

PART 3 - EXECUTION

3.01 MANUAL BALANCING DAMPERS

- A. Install manual balancing dampers in all branch ducts of supply, return and exhaust ductwork, as indicated on drawings and as required to regulate airflow to meet air balance requirements.
- B. Install manual balancing damper in branch duct to each diffuser and grille. Install dampers as close as possible to take-offs.
- C. Install balancing dampers so as not to flutter or vibrate and as far as possible upstream from the air outlet.
- D. Balancing dampers are not required for supply ductwork upstream of air terminal devices.
- E. Balancing damper is not required where terminal air device serves a single diffuser or grille.
- F. Do not install manual balancing dampers in the following exhaust ductwork:
 - 1. Fume hood exhaust ductwork.

3.02 TURNING VANES

- A. Install turning vanes as shown on drawings and for rectangular square throat elbows unless otherwise indicated. Install turning vanes in accordance with SMACNA Standards and/or manufacturer's recommendations.
- B. Turning vanes are not required in transfer air ducts.
- C. Install turning vanes so that they are tangent to airflow direction.

3.03 BACKDRAFT DAMPERS

- A. Install backdraft dampers where indicated on drawings.

- B. Where motorized dampers are shown in exhaust fan discharge duct, or in duct connecting to relief or exhaust louver, backdraft dampers are not required unless specifically indicated. Where motorized dampers are not shown, provide backdraft dampers in these locations.

3.04 FIRE DAMPERS

- A. Install dampers where shown on drawings in accordance with manufacturer's installation instructions and requirements of NFPA 90A. Install dampers complete with mounting collars, retaining angles, connections to adjoining ductwork and duct access doors. Install duct access door at each damper with door size large enough to permit replacement of fusible links and resetting of dampers.
- B. Test and demonstrate proper operation of each damper after system is installed and ready for operation.
 - 1. Manually test each damper for proper operation by removing fusible link or actuating EFL or PFL. Repair or replace any damper that does not close completely. Replace fusible link and certify in writing that each damper was installed according to manufacturer's installation instructions and that each damper can be expected to close completely when fusible link melts.
 - 2. Notify Owner and/or Owner's representative at least 48 hrs prior to testing to allow for witnessing.
- C. Contractor shall provide letter from manufacturer's representative indicating that dampers are installed per manufacturer's installation instructions.

3.05 ACCESS DOORS

- A. Install access doors as specified, as indicated on drawings, and anywhere that provision for maintenance, service, cleaning or examination is required, including each air flow meter, automatic damper, fire damper, smoke damper, smoke detector, fan bearing, heating and cooling coil, reheat coils, humidifier, filter, bird/insect screen, valve and control device within duct or casing, at outside air intake duct and at inlet side of turning vanes in return ductwork.
- B. Size and quantity of duct access doors shall be sufficient to perform intended service, but not less than the following:

<u>Rectangular Duct Size</u>	<u>Minimum Access Door Quantity and Size</u>
15" (380 mm) and smaller	(1) 16" (400 mm) x 12" (300mm)
16" (400 mm) – 21" (530 mm)	(1) 18" (460 mm) x 14" (355 mm) (1) 18" (460 mm) x 18" (460 mm)
22" (560 mm) - 27" (690 mm)	(1) 24" (600 mm) x 24" (600 mm)
28" (710 mm) – 47" (1190 mm)	
48" (1220 mm) - 96" (1240 mm)	(2) 24" (600 mm) x 24" (600 mm)
<u>Round Duct Size</u>	<u>Minimum Access Door Size</u>
10" (250 mm) and smaller	8" (200 mm) x 12" (100 mm)
15" (380 mm) and smaller	12" (300 mm) x 12" (200 mm)
29" (730 mm) and smaller	16" (400 mm) x 12" (300 mm)
30" (760 mm) and over	24" (600 mm) x 18" (460 mm)

- C. Increase duct size to accommodate access door size indicated above where required.

3.06 FLASHINGS

- A. Install counterflashings where shown on drawings. Install in accordance with SMACNA recommendations.

3.07 DUCT FLEXIBLE CONNECTIONS

- A. Install duct flexible connections between ductwork and fans or equipment casing containing fans not internally isolated. Installed width shall be suitable for specific application but shall not be less than 4" (100 mm). Install flexible connections in accordance with SMACNA Standards with double lock or "Grip Loc" connection.
- B. Provide inlet fabric duct vibration isolation section a minimum of 12" upstream of the fan inlet. The vibration inlet section is not to be used for duct misalignment and must be installed in a straight duct section. The fabric isolator is to be mounted on the exterior of the duct and may not restrict the air flow within the duct and may not enter the duct OD by more than ¼".
- C. Duct flexible connections are not allowed for fan connection serving kitchen hood, dishwasher, or perchloric acid hood.

3.08 SOUND ATTENUATING DEVICES

- A. Install sound attenuating devices as indicated on drawings and/or as scheduled.
- B. For modular installation of sound attenuators, install galvanized steel holding frame, gaskets, seals, supports and fasteners in accordance with manufacturer's recommendations for multiple unit installation.

3.09 REMOTE OPERATED VOLUME CONTROL DAMPERS

- A. Install remote operated volume control dampers and remote operators for all manual balancing dampers located above hard ceilings. Locate remote cable control near diffuser served by respective damper.

3.010 CONTROL DAMPERS

- A. Install dampers in locations indicated on drawings, as detailed and according to manufacturer's instructions.
- B. Install blank-off plates or transitions as specified in Control Sections.
- C. Provide adequate operating clearance and access to operators.

3.011 SMOKE DETECTORS

- A. Smoke detectors will be provided by Electrical Contractor in locations indicated on drawings. Install access door in ductwork for access to detector sampling device.

3.012 INSTRUMENT TEST HOLES

- A. Provide instrument test holes at air entering and air leaving side of all internal air handling system components for static pressure differential (Delta P) or temperature differential (Delta T) measurements.
- B. Provide ductwork instrument test holes as shown on drawings, or as directed by TAB personnel, or Engineer.

END OF SECTION

**SECTION 23 3400
FANS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 20 0513 - Motors
- B. Section 20 0514 - Variable Frequency Drive (VFD) System
- C. Section 23 0550 - Vibration Isolation
- D. Section 26 2816 - Enclosed Switches and Circuit Breakers

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

- A. Shop Drawings including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Identification as referenced in the documents
 - 3. Capacities/ratings
 - 4. Fan curves
 - 5. Materials of construction
 - 6. Sound power levels
 - 7. Fan type, size, class, drive arrangement, discharge/rotation, bearings, drives
 - 8. Wheel type, diameter, rpm, tip speed
 - 9. Required fan horsepower including drive losses
 - 10. Motor data (refer to Section 20 0513 - Motors)
 - 11. Vibration isolators furnished with fans
 - 12. Dimensions and weights
 - 13. Special coatings where applicable
 - 14. Color selection charts where applicable
 - 15. Manufacturer's installation instructions
 - 16. All other appropriate data
- B. Fan curves shall include series of curves indicating relationship of flow rate (cfm) to static or total pressure for various fan speeds, brake horsepower curves, and selection range (surge curves, maximum rpm, etc).
- C. Indicate performance data, based on both design air quantity and 110% of design air quantity.
- D. For variable air volume application, indicate operating points at 100, 80, 60 and 40% of design capacity on fan curves including data to indicate effect of variable frequency drives on flow, pressure and horsepower.

1.04 DESIGN CRITERIA

- A. Fan ratings shall be tested and certified in accordance with AMCA Standards 211 and 311 and fans shall bear AMCA Seal.
- B. Fans shall be furnished complete with motors, wheels, drive assemblies, bearings and accessories as hereinafter specified. Motors for V-belt drives shall be furnished with adjustable rails or bases.
- C. Each fan wheel shall be statically and dynamically balanced to grade G6.3 per ANSI S2.19. Complete fan assembly shall be factory balanced statically and dynamically in accordance with Standard AMCA 204-96 for Balance Quality and Vibration Levels for Fans and meet or exceed guidelines in Application Category BV-3.
- D. For fans furnished with 5 hp or larger hp motors, each fan assembly shall have factory run test including vibration signatures taken on each bearing in horizontal, vertical and axial direction. Filter-in reading as measured at fan, scheduled rpm shall not exceed the following values when fan is rigidly mounted.

1. Belt Drive (except Vane Axial) 0.15 in/sec peak velocity
 2. Direct Drive 0.08 in/sec peak velocity
 3. Written records of run test and vibration test shall be available upon request.
- E. System air balancing shall be accomplished by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves. Variable-pitch sheaves shall be replaced with fixed pitch when balancing is complete. Sheaves shall be constructed of cast iron or steel, bored to fit properly on the shafts, and secured with keyways of proper size (no setscrews) except that for sheaves having 13 mm (1/2 in.) or smaller, bores setscrews may be used. This Contractor shall provide necessary trial and final sheaves and drive belts as required by TAB Contractor.
- F. Select each fan to operate at single stable operating point as predicted by fan curve. Fans having 2 potential operating points on fan curves are not acceptable.
- G. Unless otherwise indicated, V-belt drives shall be selected for a minimum 150% of motor nameplate horsepower.
- H. Provide OSHA Compliant belt and shaft guards for belt driven fans. Provide speed test openings at shaft locations. Paint guards bright yellow.
- I. Sound power levels shall be based on tests performed in accordance with AMCA Standards 300 and 301.
- J. Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled static pressure. Motor furnished with fan shall not operate into motor service factor in any of these cases.
- K. Consider drive efficiency in motor selection according to manufacturer's published recommendation, or according to AMCA Publication 203, Appendix L.
- L. Where inlet and outlet ductwork at any fan is changed from that shown on drawings, submit scaled layout of change and system effect factor calculations indicating increased static pressure requirements as described in AMCA Publication 201. This Contractor shall be responsible for costs associated with any motor, drive, and/or wiring changes required as a result of duct configuration changes at fan.
- M. Provide a non-fused disconnect switch for each fan in a NEMA rated enclosure that is acceptable for the fan location application.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL FANS (INDUCED FLOW LABORATORY EXHAUST)

- A. Manufacturers: Twin City (QIFE Basis of Design), Strobic, MK Plastics, Greenheck.
- B. System to be a complete assembly with an insulated, galvanized steel curb, mixing plenum box, bypass damper(s) with electric actuator and weather cover and rain hood, fan isolation dampers with electric actuators and weather cover, mixed-flow SWSI, arrangement 9 fan with VRM discharge.
- C. General: Fans shall be mixed flow type designed for laboratory exhaust duct and suitable for continuous operation. Fans shall be UL/cUL 705 listed. Fans shall be designed for vertical base mount with NEMA premium efficiency, TEFC motors. Furnish fans with AMCA Class C spark resistant construction.
- D. Performance ratings: Conform to AMCA Standard 210, 260, and 300. Fans shall be tested in accordance with AMCA 210, 260, and 300 in AMCA accredited laboratory and certified for air and sound performance. Fan shall be licensed to bear AMCA ratings seal for air performance (AMCA 210), sound performance (AMCA 300), and induced flow fan for high plume dilution blowers (AMCA 260).
- E. Housings: Fan housing shall be bifurcated allowing drive components, including motor, to be serviced without contact of contaminated air stream. Heavy gauge steel with welded fabrication, adequate reinforcing to prevent housing distortion, fully streamlined inlet cones, multiple straightening vanes following fan wheel to redirect air flow to minimize noise and reduce turbulence and flanged inlet and outlet. Fan housings shall be designed to promote

straight line air flow from entrance to discharge. Integral fan housing drain shall be used to drain rainwater when fan is de-energized.

- F. Induction Nozzle: Air induction discharge nozzle shall be supplied by fan manufacturer, be integral to fan body design, and be designed to efficiently handle outlet velocity of up to 7000 fpm.
- G. Wheels: Wheels shall be mixed flow type with airfoil blades. Blades shall be continuously welded to back plate and wheel cone. Wheels shall be statically and dynamically balanced and complete fan assembly including motor and drive shall be test balanced at or near operating speed at factory prior to shipment.
 - 1. Fan impeller shall include a secondary fan blade located on the impeller back plate to create a negative pressure at the shaft opening.
- H. Bearings: Air handling quality, heavy duty, grease packed, cast iron, pillow block type with grease seal, furnished with external grease fittings, selected for minimum life (ABMA L-10) of not less than 80,000 h (equivalent to L-50 average life of 400,000 h) at maximum cataloged operating speed. Bearings shall be fixed to fan shaft using concentric mounting locking collars.
- I. Fan to be V-belt driven with belt tube. Motor to be VFD controlled by a remote VFD. Provide motor weather cover.
- J. Provide factory mounted NEMA 3-R, non-fused, not wired disconnect switch for each fan.
- K. General: Unless otherwise indicated, furnish fans, plenum and stacks with all carbon steel construction with special coatings specified below. Provide all stainless-steel fasteners.
- L. Fan to be AMCA Class C spark resistant construction with TEFC Motors. Motors are to be rated for VFD service.
- M. Housings: Heavy gauge steel, continuously welded throughout, braced and supported by structural channels or angle irons to prevent vibration or pulsation, flanged outlet, flanged fully streamlined inlet.
- N. Wheels: Backward Inclined (BI) blades welded to spun wheel cones.
- O. Bearings: Air handling quality, heavy duty, grease lubricated, ball or roller, self-aligning, pillow block type. Bearings shall be selected for minimum life of 80,000 h (ABMA L-10) at maximum cataloged operating speed. Furnish bearings with pressure relief type external grease fittings.
- P. V-belt Drives: Provide V-belt drive system rated for 200% of motor nameplate horsepower. Drive shall have minimum of 2 belts. Provide a spare set of belts for each fan.
- Q. Shaft: Shaft shall be Type 316 stainless steel, accurately turned, ground, polished, and ring gauged for accuracy. Shafts shall be sized for first critical speed of at least 1.43 times the maximum speed.
- R. Fan Isolation Damper: Fan isolation damper(s) shall be parallel-blade design, airfoil design, fabricated of corrosion resistance coated aluminum.
- S. Plenum Bypass Damper: Fan isolation damper(s) shall be opposed-blade design, airfoil design, fabricated of corrosion resistance coated aluminum. Provide weather hoods for all bypass dampers.
- T. Provide all 316 stainless steel hardware only.
- U. The Plenum Mixing Box shall be designed for outside service with a top designed to drain all rain and standing water. The plenum shall be provided with a factory installed welded steel bottom. The factory shall provide welded duct inlets into the bottom plenum sheet to provide a maximum 800 FPM inlet velocity into the plenum. The exhaust inlet duct shall extend 2" above the bottom sheet to prevent water in the plenum from running back down into the exhaust duct and be allowed to drain out through the plenum drains. The bottom inlet duct shall extend a minimum 6" below the plenum bottom and have a welded bolting flange. A loose mating flange shall also be provided. No field welding to the fan or plenum is allowed that would damage the protective coating.
- V. Special Coating: All fan and plenum system components shall have two part electrostatically applied and baked, corrosion resistant coating equivalent of Heresite P-413C. Coating thickness shall be 6 mils (min), not affected by UV, and have superior corrosion resistance to

acid, alkali, and solvents. Coating system shall exceed 4000 h ASTM B117 Salt Spray Resistance.

- W. Access Doors: Bolted and gasketed type in fan housing for inspection of interiors and wheel and plenum.
- X. Drain Connection: $\frac{3}{4}$ " NPT external threads located at the lowest point of fan housing.
- Y. Provide full, ventilated motor cover.
- Z. Provide wind load calculations and design for the specific location for which the fan system is to be installed. Design to be stamped by a structural engineer licensed for the state and location of the installation.

2.02 IN LINE DUCT FANS

- A. Manufacturers: Twin City, Greenheck, PennBarry, ACME.
- B. Fan housing shall be designed for installation in straight run of duct with transitions as indicated. Housing shall be designed for complete access to fan and motor without removing fan assembly from ductwork.
- C. Wheels shall have backward inclined blades. Motor or drive compartment shall be isolated from airstream and be externally ventilated. Bearings shall be prelubricated and sealed and designed for minimum life of 40,000 h operation (ABMA L-10).
- D. Paint fan parts with prime coat after metal cleaning and surface preparation. In addition, apply second coat of paint to exterior surfaces.
- E. Fan to be provided with a factory wired, non-fused disconnect switch in a NEMA 1 enclosure.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install units as shown on drawings, and according to manufacturer's installation instructions. On units provided with drain connection, install drain valve and hard copper pipe per details.
- B. Verify lubrication of motor and fan bearings and lubricate properly in accordance with manufacturer's recommendation and Section 20 0000, Part 3 under LUBRICATION.
- C. Perform field mechanical balancing, if necessary, to meet vibration tolerance specified in Section 23 0550 - Vibration Isolation.
- D. Fume exhaust fan to be installed per the installation details. Coordinate the installation of the fan with mechanical and architectural details.
- E. Where shown, provide inlet fabric duct vibration isolation section a minimum of 12" upstream of the fan inlet. The vibration inlet section is not to be used for duct misalignment and must be installed in a straight duct section. The fabric isolator is to be mounted on the exterior of the duct and may not restrict the air flow within the duct and may not enter the duct OD by more than $\frac{1}{4}$ ".
- F. Fume exhaust system manufacturer shall coordinate the duct size and location entering the plenum bottom with the mechanical contractor, with this information to be clearly shown in the fan system submittal. The fan manufacturer is to approve the duct inlet design.

END OF SECTION

**SECTION 23 3600
AIR TERMINAL DEVICES**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 23 0901 - Control Systems Integration
- B. Section 23 0993 - Control Sequences
- C. Section 23 3114 - Ductwork (Support)
- D. Section 23 3314 - Ductwork Specialties (Access Doors)
- E. Section 23 8214 - Heating and Cooling Terminal Devices

1.02 SUBMITTALS

- A. Shop Drawings including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Identification as referenced in the documents
 - 3. Capacities/ratings
 - 4. Materials of construction
 - 5. Sound rating data
 - 6. Dimensions
 - 7. All other appropriate data
- B. LEED Submittal:
 - 1. Product Data for IEQ Prerequisite 1: Documentation indicating that units comply with ASHRAE 62.1 – 2010, Section 5 – “Systems and Equipment.”

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70 by qualified testing agency and marked for intended location and application.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1 – 2010, Section 5 – “Systems and Equipment” and Section 7 – “Construction and System Start-Up.”

1.04 DESIGN CRITERIA

- A. Where any of air terminal devices are indicated on drawings to control space conditions in conjunction with reheat coil, that reheat coil may be furnished as integral part of or standard accessory to devices specified below. See related work above.
- B. When air terminal devices are furnished with reheat coils, either integrally or remotely mounted, control panels of terminal devices shall be mounted on the same side of air terminal device as reheat coil piping connection.
- C. Unless otherwise stated, units shall be system pressure independent and maintain air volume within $\pm 5\%$ of required airflow regardless of system air pressure. Inlet velocity pressure sensor shall be multi-point center averaging type and be capable of amplifying pressure signals.
- D. Unless otherwise stated, unit casings shall be constructed of galvanized steel or aluminum meeting SMACNA or ASHRAE Standards, but not lighter than 0.861 mm(22 ga).
- E. Joints and seams of air terminal devices shall be sealed with appropriate sealant to minimize casing air leakage.
- F. Unit leakage test shall comply with ASHRAE Standard 130 – Laboratory Methods of Testing Air Terminal Units.
- G. Unit performance shall be certified in accordance with AHRI Standard 880 including sound rating data certified for both casing discharge and radiated sound levels from 125 through 4000 Hz.
- H. Supply air units shall be capable of operating from minimum inlet static pressure scheduled to 750 Pa(3” WG).
- I. Air valve leakage shall not exceed 1% of maximum inlet rated airflow at 750 Pa(3” WG) inlet pressure.
- J. Casing leakage rates shall not exceed the following maximum values:

Unit Size	Max. Casing Leakage (cfm)	
	0.5" Ps(0.5" WG)	1.0" Ps(1.0" WG)
4, 5, 6	2	3
7, 8	2	3
9, 10	2	3
12	2	3
14	2	3
16	3	4

- L. Provide supply air units with internal thermal insulation faced with minimum 0.0254 mm(0.001") thick aluminum foil. Insulation shall be compressed glass fiber with minimum 19 mm(3/4") thick, 64 kg/m³(4 lb/ft³) density with R-value of 0.62 [W/(m²·°C)](3.5[(h·ft²·°F)/Btu]). Insulation and facing shall meet requirements of UL 181 (Air Erosion, Mold growth and Humidity), and NFPA 90A (Flame 25/Smoke 50) and ASTM C665 (Fungi Resistance). Secure liner with full-seam-length, galvanized steel angles or Z-strips, which enclose and seal all edges. Tape or adhesive will not be acceptable. Liner assembly shall be similar to Titus Steri-Loc.
- M. Supply air units shall be lined with engineered polymer foam insulation, minimum 19 mm(3/4") thick, 24 kg/m³(1.5 lb/ft³) density and thermal conductivity not more than 0.036 [W/(m²·°C)] at 24°C(0.25[(h·ft²·°F)/Btu] at 75°F). Insulation shall meet requirements of UL 181 (Air Erosion, Mold Growth and Humidity), NFPA 90A (Flame 25/Smoke 50) and ASTM C665 (Fungi Resistance).
- N. Sound attenuators, where specified or required to meet sound performance specified for air terminal devices, shall be constructed of all metal or sound attenuating fiber material with erosion protection liner as required to meet sound requirement specified. Refer to Section 23 3314 - Ductwork Specialties for sound attenuators and erosion protection.
- O. Unit manufacturer or manufacturer's designated representative will be required to verify air terminal device performance and adjust or replace device within warranty period when it is determined that problem exists in area served by device.
- P. Air consumption of each pneumatic control assembly shall not exceed 9.6 mL/s(35 scim (1.2 scfh)).
- Q. Room sound levels due to discharge and/or casing radiation from units when operating from minimum pressure scheduled to 500 Pa(2" WG) inlet static pressure shall not exceed noise criteria (NC) values in any spaces as indicated below. If units exceed sound level specified, provide terminal sound attenuators to comply with the noise criteria stated below. Refer to Section 23 3314 - Ductwork Specialties for sound attenuating devices.

<u>Type of Room</u>	<u>Noise Criteria (NC)</u>
All spaces unless otherwise indicated	35
Computer Rooms	40
Laboratories and Support Spaces	50
Patient Rooms	30
Libraries and Conference Rooms	30

1.05 CONTROLS COORDINATION

- A. Unit manufacturer shall provide unit inlet flow sensor, pneumatic tubing and control enclosure for Control Contractor's use.
- B. Control Contractor shall furnish all actuators, linkages if required, differential pressure transmitters, controllers and any other devices required for unit control that are not provided by

- unit manufacturer for unit manufacturer's factory mounting. Unit manufacturer and Control Contractor shall coordinate for proper factory installation.
- C. Unit manufacturer shall factory install devices furnished by Control Contractor to result in complete functioning unit. Unit manufacturer shall be responsible for reviewing compatibility of devices furnished by Control Contractor with units being provided.
 - D. Unit manufacturer shall perform preliminary calibration based on scheduled airflow rates.
 - E. Control Contractor shall be responsible for calibrating actuators and controllers through TAB work for scheduled airflow rates.
 - F. Control Contractor's field mounting will be acceptable, provided Control Contractor coordinates proper installation with unit manufacturer. Control Contractor shall be responsible for complete functioning unit.

PART 2 - PRODUCTS

2.01 VARIABLE VOLUME AIR TERMINAL DEVICES (RTU-1 AND RTU-2 OFFICES)

- A. Manufacturers: Titus, Price, Krueger, Enviro-Tec (ETI), Nailor, Carnes, Tuttle and Bailey, Metalaire, Trane, JCI or Carrier.
- B. Units shall be suitable for 24 V electric control system. Control Contractor shall be responsible for wiring from control panels to each terminal unit.
- C. Furnish units with reheat coils having capacities as indicated in schedules.
- D. Provide access doors for all air terminal devices with reheat coils at inlet side of coils. Refer to Section 23 3314 - Ductwork Specialties for access doors. Unit manufacturer's standard access doors are acceptable, provided that access doors are appropriately sized and internally lined with same materials as unit casing. If access doors are provided in separate sections as extension of units, these sections shall be internally lined in same manner as units.
- E. Provide access doors for all boxes with reheat coils at inlet side of coils. Reheat coils shall be shipped loose and field mounted. Provide sheet metal connecting section between units and reheat coils for mounting access doors. Refer to Section 23 3314 - Ductwork Specialties for access doors.

2.02 RETURN AIR TERMINAL DEVICES (RTU-2 OFFICES)

- A. Units shall be suitable for 24 V electric control system. Control Contractor shall be responsible for wiring from control panels to each terminal unit. Units shall be similar to Titus Model ECV.
- B. Return Air Terminals (tracking pair) to be used to maintain supply/return cfm offset for RTU-2 offices.
- C. Units shall be capable of modulating to full closed position with maximum leakage of 1%.
- D. Unit casing shall be minimum 0.861 mm(22 ga) galvanized steel unless otherwise specified.
- E. Casing leakage shall not exceed 1.4 L/s(3 cfm) for inlet sizes 8 and smaller and 2.4 L/s(5 cfm) for inlet sizes 9 and larger at 375 Pa(1.5" WG) differential static pressure.
- F. Damper shall be heavy gauge steel. Shaft shall be steel with bronze iolite self-lubricating bearings. Damper shall incorporate mechanical stop to prevent overstroking and synthetic seal to limit close-off leakage to 1.9 L/s(4 cfm) at 375 Pa(1.5" WG) differential pressure.
- G. Unit casing, damper and shaft for [fume hood] [fume hood and BSC] exhaust shall be 316 stainless steel.
- H. Unit shall incorporate multi-point, center averaging velocity sensor. Sensor shall provide signal measurable by controller at inlet velocities of 2.5 m/s(500 fpm). Sensor shall provide control signal accuracy of $\pm 5\%$, with the same size inlet duct at any inlet condition.

2.03 VENTURI TYPE LAB AIR TERMINAL DEVICES

- A. Reference Section 23 3614 Laboratory Temperature and Air Flow Control System

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install units as shown on drawings and according to manufacturer's installation instructions.

- B. Install units with sufficient service space to unit control, actuators and access panels.
- C. Provide minimum length of 3 times box inlet diameter of straight rigid duct at box inlet.
- D. Provide access doors for terminal devices with reheat coils at inlet side of coils.
- E. Provide access panels compatible with ceiling for all units located above non-accessible ceilings.
- F. If venturi type air terminal devices are used for supply air application, provide external insulation in accordance with Section 20 0700 - Mechanical System Insulation.

END OF SECTION

SECTION 23 3614
LABORATORY TEMPERATURE AND AIRFLOW CONTROL SYSTEM

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 20 0000 – Mechanical Systems Insulation
- B. Section 23 0595 - Air Systems Test Adjust Balance
- C. Section 23 3314 - Ductwork Specialties
- D. Section 23 8214 - Heating and Cooling Terminal Devices

1.02 DESCRIPTION

- A. This Specification is for procurement and installation of laboratory temperature and airflow control system (LTAC), complete with air valves, electric transducers, air terminal controllers, control wiring, space temperature sensors, and all accessories required, except where otherwise specified, to provide complete and functional system.
- B. Prepare Coordination Drawings as specified in Section 20 0000 - General Mechanical Requirements. As part of this effort, Contractor shall provide locations of control components to other trades, review schedule for preparation of Coordination Drawings as prepared by other contractors, attend meetings as required to assist in preparation of documents, and actively participate to resolve layout issues in timely manner.
- C. This specification applies to all spaces indicated in the Variable Volume Air Valve schedules as having Laboratory air terminals which are and applies to lab control sequences as shown on drawings.
- D. System shall be provided with independent, self-contained controls. There is no Building Automation System (BAS) included in the project design. The LTAC system contractor is responsible to provide a fully functioning system.
- E. System shall maintain continuous operation of air flow setpoints at all times.
- F. Coordinate delivery and installation schedule of air valve devices with other trades.

1.03 SUBMITTALS

- A. Refer to Division 01 - Submittal Procedures
- B. Submit Shop Drawings for all supply, general exhaust, and fume exhaust air terminals, actuators, controllers, master controllers, control wiring, pneumatic tubing, space temperature/humidity sensors and all accessories. Shop drawings shall be complete in all respects and shall include, but not be limited to the following:
 - 1. Manufacturer's printed product data sheets indicating name and model number of all pieces of equipment.
 - 2. Name, address and phone number of supplier.
 - 3. Name, address and phone number of local representative.
 - 4. Identification as referenced in documents.
 - 5. Capacity/ratings and dimensional data.
 - 6. Materials of construction and installation requirements.
- C. Submit air valve size, valve airflow setpoints, minimum and maximum airflow capacity for each valve, and space differential airflow (offset airflow) for all valves in each lab space.
- D. Bill of material identifying actual product model number used for each control device for each schematic drawing.
- E. Control drawings with graphic representation of system components. Identify controlled devices as referenced on plans with unique valve and damper tag numbers.
- F. Electrical characteristics indicating any field wiring which is to be performed by others, type of signal wiring, and installation methods including raceway type and grounding method.
- G. Supply and exhaust air terminal certified sound data for both casing discharge and radiated sound levels from 125 through 8,000 Hz as tested in accordance with ASHRAE/ANSI Standard 130, S12.12 or AHRI Standard 880.

- H. Instrument specifications.
- I. Controller description.
- J. System/network architecture configuration diagram showing all controller / control panel types and locations and interconnecting wiring and interface points.
- K. Written control sequences describing method of control, alarms, setpoints referenced to tag number of device.
- L. Outline drawing showing overall dimension, component location and spacing, and interfacing connections sizes and locations.
- M. Identify setpoint or adjustable control range for each control device.
- N. Submit Building Automation System integration point list indicating point types, point names, and read/write capability.
- O. Shop Drawings and complete equipment and software descriptions shall be submitted in sufficient detail to assess equipment's conformance to this specification and physical size of equipment.
- P. Organize submittal with table of contents and tabs for each section arranged by logical groups of devices.

1.04 DESIGN CRITERIA

- A. Unit manufacturer or designated representative shall verify LTAC system performance and adjust or replace device(s) within warranty period if it is determined that problem exists in area served the by LTAC system or the associated device(s).
- B. Actuators and linkages shall be furnished and factory installed by Laboratory Temperature and Airflow Control Manufacturer.
- C. Actuator and its controller shall be calibrated at the factory, and then verified through TAB work for scheduled airflow rates. Air terminals shall be capable of field calibration and readjustment with external gauge taps.
- D. Refer to Air Valve Device schedules for definition of minimum inlet static pressure requirement for each air terminal device as well as sizing criteria.
- E. Provide all components not specifically indicated or specified, but necessary to make system function within intent of specification and in accordance with control sequences.
- F. Size all control apparatus including all air terminals to provide stable control of systems and equipment served throughout specified operating range.
- G. Any devices subject to corrosion, such as in fume hood exhaust ducts, shall be provided with appropriate corrosion protection.

1.05 CODES AND STANDARDS

- A. All materials and workmanship described herein shall be in accordance with latest addition and addenda of codes and standards listed below:
 - 1. AMCA Air Movement and Control Association
 - 2. AHRI Air Conditioning, Heating, and Refrigeration Institute
 - 3. ASTM American Standards Testing and Materials
 - 4. NEC National Electrical Code
 - 5. NEMA National Electrical Manufacturers Association
 - 6. NFPA National Fire Protection Association
 - 7. UL Underwriters Laboratories
- B. All work shall also comply with latest edition of the Florida Building Code.

1.06 FCC COMPLIANCE

- A. All equipment furnished under this Contract shall have been tested and made to comply with limits for Class A computing device pursuant to Subpart J of part 15 of FCC Rules, which are designed to provide reasonable protection against interference when operated in commercial environment. Literature shall so note and all equipment shall be so labeled to show this compliance.

1.07 ADJUSTMENT, PERFORMANCE TEST AND CERTIFICATION

- A. Conduct complete performance test for all systems to assure compliance with Contract Documents. Any components on systems found defective or not performing satisfactorily shall be readjusted and retested after necessary corrective measures are performed. Corrective measures may include modification or addition of equipment and devices, control strategies and/or software program.
- B. Provide written certification signed by applicable person(s) for incorporation in O&M manuals stating date when successful completion of performance tests is achieved. Letter shall verify all controls are installed and software programs have been completely exercised for proper equipment operation.
- C. Demonstrate functionality to Commissioning Agent.
- D. Each air valve shall be factory calibrated to job specific airflows as detailed on plans and specifications using NIST Traceable Air Stations and instrumentation having combined accuracy of at least $\pm 1\%$ of signal over entire range of measurement.
- E. Air valves shall be individually marked with air valve specific model number, and quality control inspection numbers. Information shall be stored electronically by manufacturer for future retrieval or for hard copy printout to be included with as-built documentation.

1.08 GUARANTEE

- A. Guarantee all work, materials, equipment, and controls against defects in workmanship and material per General Conditions. Warranty shall commence upon the date of shipment and extend for a period of 60 months. During this period, any defects in material or critical or non-critical airflow control system performance shall be repaired or replaced by the supplier at no cost to the owner.
- B. Replace any defective workmanship or material developing within that time as soon as possible at no charge to Owner.
- C. After completion of installation, manufacturer shall regulate and adjust equipment provided in this contract prior to final acceptance.

1.09 OWNER TRAINING

- A. Laboratory Temperature and Control System Contractor shall have designated representative available to monitor/modify lab control systems after systems have been started and are regularly used until Owner has completed on-site training specified.
- B. Provide minimum of 12 hours of on-site training to Owner's representatives. Conduct training sessions during normal working hours after system start-up and acceptance by owner. Scheduling of training session(s) will be established by Owner and shall include both classroom and hands-on training. Portions of training may be performed before system is completely operational, but no sooner than 1 month before system is planned to be fully operational. Final training session shall be held after systems are complete, including all graphics programming.
- C. Training sessions shall include, but not be limited to, the following topics:
 - 1. Explanation of control sequences. Include which sensors are used and how output device operates.
 - 2. Explanation of control drawings and manuals, including symbols, abbreviations, and overall organization.
 - 3. Walk-through of Project to identify controller locations and general routing of network cabling.
 - 4. Review of operation and maintenance of hardware devices including controllers, instruments, and sensors. Include schedule for routine maintenance.
- D. Instructions on how to monitor and operate system hardware and software, and how to change system set points, flow rates, etc and respond to alarms.
- E. Review interface for troubleshooting using operator interface device.

- F. Training sessions shall be conducted during separate visits to site from site visits for system adjustment, performance test and certification.
- G. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided for each training attendee.

1.010 OPERATING AND MAINTENANCE MANUALS

- A. Refer to Division 01 - General Requirements
- B. Operating and maintenance manuals shall provide descriptions of maintenance on all system components including sensors and controlled devices. These shall include Control Contractor's completion check list, inspection requirements, periodic preventative maintenance, cleaning methods and materials, troubleshooting guide, calibration instructions and tolerances, repair parts lists, and manufacturer representative's name, address, and phone number.
- C. O&M Manuals shall also include interconnection wiring diagrams with identified and numbered system components and devices.

1.011 RECORD DRAWINGS

- A. Refer to Division 01 - General Requirements
- B. Submit revised Shop Drawings indicating all changes made during project including any changes to operating sequences or setpoints.
- C. Update control diagrams to include all tuning parameters and setpoints applicable to systems as depicted as of date of system completion. This information shall be incorporated with sequence of operation of each system.
- D. Record actual locations of control components including control units, temperature/humidity sensors, air terminals and any controlled devices on As-Built ductwork/piping plans provided by Mechanical Contractor.

1.012 COORDINATION

- A. Coordinate final supply, general exhaust, and fume exhaust air flow setpoints for valves in spaces with fume hoods with the fume hood manufacturer and the approved fume hood submittal.
- B. Design and drawings are based on one of acceptable manufacturers listed in this Specification. Where requirements of equipment provided differ from equipment on which design is based, the Contractor shall be responsible for coordinating requirements of equipment with other Contractors involved. The Contractor shall be responsible for any additional cost incurred due to such requirements.
- C. Contractor shall be responsible for all costs required for all revisions necessary to provide LTAC that meets the intent of the contract documents. Revisions include, but are not limited to additional Test, Adjust, and Balance work, ductwork revisions, insulation of supply air valves, power modifications, integration costs, etc.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Manufactures: Phoenix Controls, Siemens, Price, or Tek-Air. Basis of design is Phoenix Controls.
- B. Materials shall be new and unused and free from defects and imperfections.
- C. LATC system shall be fully stand-alone for each individual laboratory or laboratory support space. System shall not use or rely on information from controllers in other laboratory areas or from outside laboratory space to control functions within its laboratory.
- D. Electrically actuated air valves shall be pressure independent with airflow accuracy of $\pm 5\%$ over airflow range of terminal. Air terminal units shall be balanced to conform to requirements of Section 23 0595 – Air Systems Test Adjust Balance.
- E. Laboratory airflow control system shall use volumetric offset to maintain room pressurization. Offset airflow is indicated for each lab on Air Valve Device schedule.

- F. Fume hood controllers will be provided by the fume hood manufacturer and are not included in this specification.
- G. Control wiring shall meet requirements of Division 25. Control panels shall be located near entry to each lab zone. Coordinate location of control panel with all trades to provide access to panel for maintenance. Provide communications jack as part of or adjacent to space temperature sensor to allow communication between laptop computer and control panel. Provide one control panel to allow for stand-alone control of each lab zone.

2.02 LABORATORY CONTROLS SYSTEM

- A. Air Valve Devices - General:
 - 1. Air terminals shall be venturi-type (Low-Pressure type), pressure independent over a 0.3 to 3.0 inches WG drop across the air terminal. Valves shall be the Low-Speed type with BacNet based controls. An integral pressure independent assembly shall respond and maintain specific airflow within 60 seconds of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifold system.
 - 2. Airflow accuracy shall be $\pm 5\%$ of airflow (not velocity pressure) over an airflow turndown range of no less than 10 to 1.
 - 3. Response time to vary air flow from its minimum to maximum value or vice versa shall be less than 60 seconds for supply/general exhaust tracking pair valves (Low-Speed type).
 - 4. Include necessary instruments to maintain air flows at design conditions at all times.
 - 5. Sound: Radiated and discharge sound power levels shall be no greater than published values for the basis of design air valves.
 - 6. All supply and general exhaust valves shall be furnished with a galvanized steel sound attenuator designed specifically by the air valve manufacturer to mitigate the valve generated sound.
- B. Supply and General Exhaust Air Valves:
 - 1. Air valves for non-corrosive airstreams, such as supply and general exhaust air, shall be constructed of uncoated 16-gauge aluminum or 20 ga galvanized steel. The air valve's shaft and shaft support brackets shall be made of 316-stainless steel. The pivot arm and internal mounting brackets shall be made of a combination of aluminum and stainless steel. The pressure independent springs shall be of combination 302 and 316 stainless steel. All shaft bearing surfaces shall be made of a Teflon or Celenex composite.
 - 2. Furnish manufacturer's two-bolt band clamp. Band clamps shall have stepped design to accommodate nominal differences in duct diameter and valve diameter. Band clamp shall be galvanized steel with Volara Type AFR gasket conforming to UL94 for foamed plastics. Bands shall be provided with PTFE tape with silicone adhesive.
 - 3. Supply valves and general exhaust valves shall be factory insulated with closed cell foam insulation.
 - 4. Furnish supply valves with controls for HHW duct reheat coils (Ref Section 23 8214). Provide proper duct transitioning from the air valve to the sound attenuator to the reheat coil. Include a duct access door between the air valve and the coil for coil servicing.
- C. Fume Exhaust Air Valves:
 - 1. Air valves for corrosive airstreams, such as fume hood, snorkel, flammable storage cabinet and equipment exhaust shall be either 316 stainless steel or minimum 16 ga aluminum with two baked-on coats of Heresite P-403, 5 mils minimum thickness. Air valve's shaft and shaft support brackets shall be made of 316-stainless steel. Pivot arm and internal mounting brackets shall be made of a combination of aluminum and 316L stainless steel. Pressure independent springs shall be of combination 302 and 316 stainless steel. All shaft bearing surfaces shall be made of Teflon or Celenex composite.
 - 2. Furnish manufacturer's two-bolt band clamp. Band clamps shall have stepped design to accommodate nominal differences in duct diameter and valve diameter. Band clamp shall

be galvanized steel with Volara Type AFR gasket conforming to UL94 for foamed plastics. Bands shall be provided with PTFE tape with silicone adhesive.

D. Air Valve Actuators

1. Furnish actuators for all air valves (including constant volume). For VAV operation, electric actuator shall be factory mounted to air valve. Loss of main control power shall cause exhaust air valves to fail to the last position. Actuators and all controls shall be all Native BacNet. Variable volume air valves are to be Phoenix Traccel Model MAV or EXV (low-speed actuators), or approved equal.

E. Air Valve Controllers:

1. Controller shall use electronic-based, closed loop control to regulate airflow.
2. Supply air valve controller shall control the general exhaust air valve to maintain the constant room offset.
3. Supply air valve controller shall control the fume exhaust air valve and include that flow rate into the room offset equation.
4. The room temperature sensor shall provide an input to the supply air valve controller. The controller shall then control the reheat coil control valve to maintain room temperature conditions.
5. The controller shall communicate with the BAS via a native BacNet communication interface. The BAS will then be able to observe all internal points and be able to input setpoint changes such as temperature and room cfm offsets into the valve controller.

F. Laboratory Temperature and Airflow Control System Control Unit:

1. Minimum Requirements:
 - a. Ambient Temperature; 35° F -120° F
 - b. Humidity: 10%-90%
 - c. Analog Outputs: 0-10VDC or 4-20ma
 - d. Room Temperature Control: 0.5° F
2. Laboratory controller shall maintain proper room pressurization by maintaining constant design offset (adjustable) between sum of room's total exhaust and make-up/supply airflows.
3. Provide control of the HHW reheat coil to maintain space temperature. Provide devices as required to interface with reheat controls.
4. Controller shall use electronic-based, closed loop control to regulate airflow. Each laboratory shall operate independent and on a stand-alone basis. There shall be no communication with a central controller.
5. Sequences shall be field customized by adjusting parameters such as control algorithm gains, temperature setpoint, alarm limits, air flow differential setpoint, and pressurization mode.
6. Include a communication jack to allow remote programming of laboratory temperature and airflow control system via laptop computer.
7. Controller shall include all inputs and outputs necessary to perform specified control sequences.

G. Room Temperature Sensors:

1. Sensor shall include communication jack to allow remote programming of CCU via laptop computer. Minimum requirements include:
 - a. Temperature Coefficient of Resistivity (TCR): .00385 ohm/ohm/°C
 - b. Accuracy: ± 0.5° F
 - c. Conformance: DIN-IEC 751
 - d. Operating Range: 32 to 122°F
0 to 95% RH

H. Fume Hood Monitor:

- a. By others, furnished by the lab hood manufacturer. No communication with the BAS or air valve controls is to be provided.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install all supply, general exhaust, and fume exhaust air valves in accordance with the manufacturer's installation instructions, including upstream and downstream straight duct lengths as required. Coordinate with other work to provide appropriate duct configuration to allow for accurate measurement and control of airflow as required for each device.
- B. Do not cover the Air Valve Information Tag with duct insulation, tape or mastic.
- C. Provide all low voltage transformers and control wiring and 24 VAC power supplies.
- D. Air Valves and Reheat Coils:
 1. Coordinate with other trades to install air valves, sound attenuators, reheat coils and access doors as shown on drawings and according to manufacturer's instructions, including reheat coil controls and access doors and necessary ductwork transitions as required for mounting equipment.
 2. Mount air valve actuators on same side of air terminal device as reheat coil controls to ensure service access.
 3. Connect air terminals to ductwork with removable type joints as detailed.
 4. Transition from supply air terminal to reheat coil shall not exceed 15° per side.
 5. Provide access doors for supply air terminals with reheat coils. Mount access door at inlet side of coil. Refer to Section 23 3314 - Ductwork Specialties for access door requirements.
 6. Air terminal devices used for supply air and general exhaust applications shall be provided with external insulation in accordance with Section 20 0000 – Mechanical Systems Insulation.
- E. Sound Attenuating Devices
 1. Coordinate installation of sound attenuating devices with other trades where provided separate from valves.
- F. Control and Power Wiring:
 1. Provide control wiring from laboratory control panel to and between other laboratory control system components as required for complete and proper functioning, including but not limited to air terminals, reheat control controls, sensors, transducers, controllers, panels, and interface modules.
 2. Division 26 is to provide required conduit, wire, junction boxes, disconnect switches and circuit breakers according to Division 26 specifications as required to wire electrical power to each laboratory control panel. Division 26 will provide one 120-volt circuit to each lab zone as required.
- G. Laboratory Control Panels and Power Supplies:
 1. Mount laboratory control panels and power supplies in accessible location within laboratory rooms. Provide a properly sized and fused 24 Vac transformer suitable for NEC Class II wiring for each lab zone control system as defined in the previous section.
 2. Coordinate location of electrical power panels with Division 26 Contractor.
- H. Laboratory Control System Start-up:
 1. System startup shall be provided by factory authorized representative of system manufacturer.
 2. Coordinate timing of start-up with Mechanical Contractor to confirm HVAC Systems are operating as specified.
 3. Startup shall be performed on complete laboratory temperature and air flow control system and shall include calibration of each laboratory control system component; check out of air valves, actuators, sensors, thermostats, and verification that each system operates in compliance with specified control sequences.

4. Measure and set up fume hood average face velocity. Coordinate with and work in conjunction with TAB Contractor.
 5. Set up system supply, general exhaust, and fume exhaust air flows in cooperation with TAB Contractor. Refer to Section 23 0595 - Air Systems Test Adjust Balance for air flow measurements.
 6. Provide a visual demonstration that the laboratory airflow systems are maintaining specified containment performance requirements for fume hoods and room to room air directional offset. If the performance requirements cannot be demonstrated, Contractor shall be responsible for any costs and labor necessary to meet minimum performance requirements. Coordinate with and work in conjunction with TAB Contractor.
 7. Demonstrate that, with specified room offset, system maintains proper room directional air flows under both static and dynamic operating conditions under all air flow conditions. The fume hood and snorkel units are constant volume, so air balance is to be maintained by the offset between the supply and general exhaust valves. Verification shall be provided by temporary visual indication, using smoke wand. If performance requirements cannot be demonstrated, Contractor shall be responsible for any costs and labor necessary to meet minimum performance requirements. Coordinate with and work in conjunction with TAB Contractor.
- I. Draw Bands
1. Draw bands for air valves shall be manufactured and supplied by air valve manufacturer. Ductmate quick sleeve or approved equal will be acceptable. Contractor fabricated band clamps are not allowed. Provide each valve with manufacturer's teflon gasket/tape to seal between clamp and seal.

END OF SECTION

**SECTION 23 3713
DIFFUSERS, REGISTERS AND GRILLES**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 23 3600 - Air Terminal Devices

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

- A. Shop Drawings including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Identification as referenced in the Documents
 - 3. Capacities/ratings
 - 4. Materials of construction
 - 5. Sound ratings
 - 6. Dimensions
 - 7. Finish
 - 8. Color selection charts where applicable
 - 9. Manufacturer's installation instructions
 - 10. All other appropriate data

1.04 DESIGN CRITERIA

- A. Performance data shall be based on tests conducted in accordance with ASHRAE Standard 70.
- B. Screw holes on surface shall be counter sunk to accept recessed type screws.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Titus, Price, Carnes, Nailor, Anemostat, or Krueger
- B. Acceptable manufacturers for specialty products are listed under each item.

2.02 CEILING DIFFUSERS

- A. Diffusers shall be aluminum construction unless otherwise indicated, and furnished with frame type appropriate to installation. Furnish diffusers with equalizing grids where it is not possible to maintain minimum 2 times duct diameter straight duct into diffuser. Equalizing grids shall consist of individually adjustable vanes designed for equalizing airflow into diffuser neck and providing directional control of airflow.
- B. Diffuser models, sizes and finishes shall be as shown on drawings and/or as scheduled. Unless noted otherwise, diffusers shall have baked enamel finish with color selected by Architect.

2.03 REGISTERS AND GRILLES

- A. Registers and grilles shall be aluminum unless otherwise indicated, and furnished with frame type appropriate to installation.
- B. Supply registers and grilles shall be double deflection type blades to provide for air deflection adjustment in all directions.
- C. Return and exhaust registers and grilles shall have fixed blade core.
- D. Registers shall be furnished complete with opposed blade volume control dampers, operable from face.
- E. Register and grille models, sizes and finishes shall be as shown on drawings and/or as scheduled. Unless noted otherwise, registers and grilles shall have baked enamel finish with color selected by Architect.

- F. Interior of perforated face grilles shall be finished in flat black.

2.04 ADJUSTABLE LINEAR DIFFUSERS

- A. Linear diffusers shall be extruded aluminum and furnished with frame type appropriate to installation with diffuser elements being removable from frame. Diffuser vanes shall provide both air pattern and flow rate adjustment with air pattern having full 180° adjustment. Diffuser vanes of single slot shall be segmented on 2 or 3 ft centers.
- B. Diffuser models, lengths and slot sizes shall be as shown on drawings and/or as scheduled. Unless otherwise indicated, frame face shall have baked enamel finish with color selected by Architect. Diffuser vanes and frame interior shall be finished in flat black.

2.05 WIRE MESH GRILLES

- A. Grilles shall be 2 X 2 mesh (1/2") galvanized steel or aluminum hardware cloth in spot welded galvanized steel frame with 1-1/2" width.

PART 3 - EXECUTION

- A. Install grilles, registers and diffusers as shown on drawings and according to manufacturer's instructions.
- B. Unless otherwise indicated, size ductwork drops to diffusers or grilles to match unit collar sizes. Where diffuser or grille has square neck, provide round-to-square duct transition to allow connection of flexible duct.
- C. Seal connections between ductwork drops and diffusers/registers/grilles air tight.
- D. Blank off unused portion of linear diffusers and grilles.
- E. Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.
- F. Protect diffusers, registers and grilles from construction dirt. Clean or replace those soiled or stained prior to turnover to Client.
- G. Install wire mesh grilles on fan coil unit discharge openings and open-ended supply ducts on fan coil units.

END OF SECTION

**SECTION 23 4114
FILTERS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 23 36 00 - Air Terminal Devices
- B. Section 23 37 13 – Diffusers, Registers and Grilles
- C. Section 23 7400 – Packaged Rooftop Air Handling Units

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

- A. Shop Drawings including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Identification as referenced in the Documents
 - 3. Capacities/ratings; cfm, area, face velocity
 - 4. Efficiencies and initial/final pressure drop
 - 5. Materials of construction
 - 6. Dimensions
 - 7. Filter gauges data
 - 8. Manufacturer's installation instructions
 - 9. All other appropriate data
- B. LEED Submittals:
 - 1. Product Data for IEQ Prerequisite 1: Documentation indicating that units comply with ASHRAE 62.1-2007 Section 5 – “Systems and Equipment”.
 - 2. Product Data for IEQ Credit 4.1: For adhesives and sealants, including printed statement of VOC content.

1.04 DESIGN CRITERIA

- A. Filters shall have UL, Class I or Class II Listing.
- B. Holding frames or housings specified in this Section may be furnished by filter manufacturers listed below, or where applicable, as part of factory packaged air handling units.
- C. Filter sizes shall be 16x20, 20x20, 20x25, or 16x25.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. American Air Filter, Camfil/Farr, Flanders Precisionaire, Glasfloss, Airguard or Filtration Group unless otherwise noted under individual filter.

2.02 DISPOSABLE PANEL FILTERS (OA ROUGHING FILTER – ALL RTUS)

- A. Similar to Farr 30/30 or Flanders Precisionaire PrePleat 40.
- B. Filter size, capacity, and efficiency shall be as scheduled.
- C. Media shall be non-woven, fine fibered material laminated to rigid backing to hold pleat formation, having minimum efficiency MERV 8 based on ASHRAE Test Standard 52.2 (average dust spot efficiency of 30 to 35% based on ASHRAE Test Standard 52.1).
- D. Filter housing shall consist of air handling or cabinet fan unit manufacturer's low velocity filter section, or holding frame, as scheduled. When holding frame is indicated, it may be furnished by, filter manufacturer or it may be contractor fabricated.
- E. Clean filter pressure drop shall not exceed 0.31" WG (70Pa) based on 500 fpm (153m/m) face velocity.

2.03 DISPOSABLE RIGID CARTRIDGE TYPE AIR FILTERS

- A. Similar to Camfil Farr Durafil ES RIGA-FLO or Flanders Precisionaire

- B. High performance deep pleated, rigid, disposable type filters. Each filter shall consist of high efficiency media, enclosing frame, contour stabilizers on both air entering and exiting sides and support grilles. Filters shall be designed to withstand minimum differential pressure of 6" WG without structural damage to filter frame, seals or media.
- C. Filter thickness, size and capacity shall be as scheduled.
- D. Filters shall have minimum efficiency MERV 11 based on ASHRAE Test Standard 52.2 (average efficiency of 60-65% based on ASHRAE Test Standard 52.1). Initial resistance at 500 fpm face velocity shall not exceed 0.31 WG. (OA Final Filter – All RTUs)
- E. Filters shall have minimum efficiency MERV 13 based on ASHRAE Test Standard 52.2 (average efficiency of 80-90% based on ASHRAE Test Standard 52.1). Initial resistance at 500 fpm face velocity shall not exceed 0.50 WG. (Supply Final Filter – All RTUs)

2.04 FILTER HOLDING FRAMES

- A. Frames shall be minimum 16 ga (1.6mm) stainless steel construction with provisions for assembly in a bank. Frames shall be suitable for filters scheduled and incorporate gaskets and spring clips to prevent air bypass.

2.05 LOW VELOCITY FILTER SECTIONS

- A. Provide for factory packaged, air handling units and cabinet fans as indicated.
- B. Housing shall consist of modular steel section with hinged access doors for filter replacement. Each housing shall be internally insulated by manufacturer or externally insulated in the field. Factory applied internal insulation shall have thermal resistance equivalent to that specified for duct in which housing is located, shall have internal vapor barrier, and shall have flame spread and smoke developed ratings as specified in Section 20 0700 - Mechanical Systems Insulation.

2.06 FILTER PRESSURE DROP GAUGES

- A. Dwyer Series 2000 Magnehelic pressure gauge.
- B. Unless otherwise indicated below, select scale range to be most appropriate to clean and dirty filter pressure drops.

<u>Filter Type</u>	<u>Scale Range - inch WG (Pa)</u>
Throwaway filters	0 - 0.5 (0-125Pa)
Filters with 25 to 30% efficiency based on atmospheric dust spot test	0 - 1.0 (0-250Pa)
Filters with 31 to 99% efficiency based on atmospheric dust spot	0 - 2.0 (0-500Pa)
HEPA filters	0 - 4.0 (0-1000Pa)
ULPA filters	0 - 4.0 (0-1000Pa)

- C. Provide gauges for each filter bank, including gauges across each individual filter bank in built-up rack assemblies, suitable for flush mounting in a panel, including air filter gauge accessory package for use with 1/4" (6.5mm) OD copper tubing.
- D. Provide 3/4" (19mm) spacer at one 2' x 2' (0.6m x 0.6m) filter section between filter elements in built-up rack, adjacent to unit wall for placement of intermediate pressure probe.

2.07 ADDITIONAL FILTER MEDIA

- A. For Disposable Panel filters, enough media for 3 filter changes shall be provided for each air handler. Media used during construction shall be replaced when system is air balanced. Third set of media not used shall be turned over to Owner as spare.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install filters as shown on drawings and according to manufacturer's instructions.
- B. Provide supports as required and necessary clearance for changing filters.
- C. Provide structural supports, outside casing and blank-off materials for all field assembled filter banks, and filter banks where housings are not furnished by filter manufacturer.

3.02 FILTER PRESSURE DROP GAUGES

- A. Mount gauge near each filter bank and install static pressure sensors according to manufacturer's instructions.

3.03 FILTER HOLDING FRAMES

- A. Provide frames for all filter banks as required. Install built-up filter banks in accordance with manufacturer's installation instructions.

END OF SECTION

**SECTION 23 5100
SMOKESTACK, BREECHING AND VENT PIPING**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 23 5214 – Primary Heating Equipment

1.02 SUBMITTALS

- A. Shop Drawings including, but not limited to, the following:
 1. Manufacturer's name.
 2. Pressure/temperature ratings.
 3. Materials of construction.
 4. Dimensions and weights.
 5. Thermal characteristics.
 6. Erection and supporting methods.
 7. Finish.
 8. Manufacturer's installation instructions.
 9. All other appropriate data.

1.03 DESIGN CRITERIA

- A. All products, fabrication and installation shall comply with requirements of NFPA 211 together with State and Local Codes.

PART 2 - PRODUCTS

2.01 FACTORY-BUILT BOILER VENT SYSTEM FOR CONDENSING BOILERS

- A. Manufacturers: Metal-Fab, HeatFab, ProTech Systems or Schebler equal to HeatFab SAF-T Vent or SAF-T CI Vent.
- B. Smokestack shall be factory-built double wall type with minimum 5/32" air space between walls. Stack shall be listed by UL 1738/ULS S636 listed for continuous operation at 550°F.
- C. Inner pipe shall be AL-29-4C superferritic stainless steel in 0.015" minimum thickness for sizes through 12" ID and 0.024" minimum for sizes over 14 through 24" ID.
- D. Outer jacket shall be Type 304 or Type 430 stainless steel.
- E. Provide stack system complete with all necessary accessories including flashing, counterflashing, storm collar, ventilated roof thimbles, fitting, cleanout and drain section, base anchor lugs and necessary supports.
- F. When specifically allowed by the manufacturer of the condensing boiler, Schedule 40 Polyvinyl Chloride (PVC) Piping with ASTM D2665 solvent weld PVC fittings may be used for the outside combustion air intake and the boiler exhaust venting in place of the metal venting systems listed above.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install stack, breeching, vents and expansion devices as shown on drawings, details and in accordance with manufacturer's recommendations and code requirements for minimum heights and distances. Coordinate carefully with General Contractor.
- B. Support vents and combustion air ducts adequately from building structure with provisions for breeching expansion and contraction.
- C. The vent pipes shall be installed in such a manner that provides a positive draining of condensate liquids or water that has accumulated in the vent pipe.
- D. The vent pipes shall be installed per local codes for height and separation. Provide wind bracing or guy wires where required.
- E. When PVC pipe is used for venting, use cleaning procedures and solvent cements as recommended by pipe and fitting manufacturers for the particular material being used. Install PVC piping in strict accordance with pipe and fitting manufacturer's recommendations,

including support spacing, compensation for thermal expansion and contraction and solvent cementing.

END OF SECTION

**SECTION 23 5214
PRIMARY HEATING EQUIPMENT**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 20 0700 – Mechanical Systems Insulation
- B. Section 23 0901 - Control Systems Integration
- C. Section 23 2118 - Valves
- D. Section 23 2120 – Piping Specialties
- E. Section 23 5100 – Smokestack, Breeching, and Vent Piping

1.02 SUBMITTALS

- A. Shop Drawings for all items in this Section including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Identification as referenced in the documents
 - 3. Capacities/ratings
 - 4. Materials of construction
 - 5. Dimensions and weights
 - 6. Temperature/pressure ratings
 - 7. ASME Construction and Stamp
 - 8. Wiring diagrams
 - 9. Manufacturer's installation instructions
 - 10. All other appropriate data

1.03 DOCUMENTATION

- A. As the equipment is being constructed, the manufacturer shall record all component information such as model numbers and serial numbers for all replaceable components including motors, fans, control components. In addition, all sensors shall be listed in a table with associated model number and calibration certifications.
- B. The information requested above shall be forwarded to the owner and engineer (2 copies each) prior to the arrival of the equipment.

1.04 CERTIFICATES

- A. Secure all registration and installation permits required by State and Local Authorities and complete these requirements before system is placed in operation.

1.05 REFERENCE STANDARDS

- A. Boilers shall be constructed, tested and stamped in accordance with the latest ASME Boiler and Pressure Vessel Code and must receive authorized boiler inspection in factory.
- B. Boiler shall be constructed, installed and tested in accordance with ASME CSD-1 2009, Controls and Safety Devices for Automatically Fired Boilers.

1.06 STARTUP, TESTING, TRAINING, AND OPERATION AND MAINTENANCE DATA

- A. Boilers:
 - 1. General: Boiler manufacturer shall provide services of factory-trained field representative/technician to approve installation, conduct start-up, test and adjust for proper operation, pre-test, conduct witnessed testing, and instruct and train Owner's representative in operation and maintenance of equipment. Boiler manufacturer shall submit résumé for representative/technician(s) actually conducting these services. Representative/technician(s) shall have at least 5 yrs of experience commissioning condensing boiler systems. All procedures shall be conducted for each boiler and the integrated boiler system as specified herein.
 - 2. Boiler Startup: Boiler manufacturer's representative shall conduct startup of boilers per manufacturer's recommended startup procedures. Startup shall include the following in addition to manufacturer's recommended startup procedures:

- a. Complete inspection of installation and boiler condition
 - b. Fireside and waterside inspections
 - c. Verification of installation of field installed components, connections, wiring, and mountings. This verification shall include remote-mounted burner controller panel and interconnections to boiler skid components, and stack sensors. Verify that control panels are at mounting height allowing easy readability, access, and keyboard manipulation from floor level.
 - d. Verification of boiler mounting to achieve seismic restraint and allow for boiler thermal expansion
 - e. Verify strainers are clean and watertight
 - f. Setup of gas and fuel trains
 - g. Setup of combustion air system including complete VFD setup
 - h. Setup of all operating parameters
3. Boiler Pre-Testing: After startup is complete, boiler manufacturer's representative shall conduct testing of boiler functional operations per manufacturer's recommended testing procedures. All testing shall require detailed, written procedures and shall be submitted to Engineer for approval prior to testing. Boiler manufacturer's representative shall provide all temporary testing equipment and instrumentation required for startup and commissioning. Testing shall include the following in addition to manufacturer's recommended test procedures:
- a. Coordinate and assist Building Automation System (BAS) Contractor and/or third-party integrator in installation and verification of all boiler controls/DDC controls interface functions. Testing shall not be considered complete until all interface functions are verified to operate correctly.
 - b. Verify operation of all boiler safeties including gas limits, flame safeguards including timings, low water cutout, auxiliary low water cutout, proof of air pressure/flow, high limits, relief valves, indication of correct fault messages/codes at boiler controller, indication correct alarm reporting through communications to BAS, etc.
 - c. Verify operation of combustion process including timings.
 - d. Testing of boiler combustion air/fuel ratios and emissions analysis throughout firing range and for each fired fuel. Flue gas analysis report shall include measurements of the following throughout the firing range:
 - 1) % oxygen
 - 2) % carbon dioxide
 - 3) % carbon monoxide
 - 4) stack temperature
 - 5) % combustion efficiency
 - 6) NOX mg/L(ppm)
 - 7) SOX mg/L(ppm)
 - 8) Verification of boiler turndown.
4. Final Report:
- a. Upon completion of these services, boiler manufacturer's representative shall submit complete report, signed by manufacturer's service representative, including start-up and test log. Final test report shall include reports for all startup/commissioning tests and procedures. Final completed commissioning functional test procedures shall be signed-off from manufacturer's technician. Report shall document all setpoints and user-adjustable parameters as configured on each boiler.

1.07 OPERATION AND MAINTENANCE DATA

A. Owner Training:

1. Provide 16 hours of training on-site as scheduled with Owner. Provide one additional 8 hour training session at a later date to be scheduled with Owner. Training shall be for up to

8 people. Training shall include basic system descriptions and operations, safety procedures, maintenance procedures, controls functions and operations, and diagnostic/trouble-shooting procedures.

B. Operation and Maintenance Manuals:

1. Provide Operation and Maintenance (O&M) Manuals including cut-away drawings of boilers, boiler piping diagrams including fuel trains, complete boiler electrical wiring diagrams with interface points, controls sequences and schematic diagrams with interface points, component cut-sheets, complete spare parts lists, maintenance procedures/intervals, inspection procedures, safeties testing procedures, and trouble-shooting procedures.

1.08 COORDINATION

- A. Design and drawings are based on one of acceptable manufacturers listed in this Specification. Where requirements of equipment provided differ from equipment on which design is based, this Contractor shall be responsible for coordinating requirements of equipment with other Contractors involved.
- B. This Contractor shall be responsible for any additional cost incurred due to such requirements.

1.09 WARRANTY PERIOD FOR CONDENSING BOILERS

- A. Provide 1 year non-prorated parts warranty on all burner components
- B. Provide 10-year non-prorated heat exchanger warranty for failure due to thermal stress and corrosion. Failure due to improper water treatment is not covered in this warranty.
- C. Warranty period begins at the date of equipment startup.

PART 2 - PRODUCTS

2.01 BOILER-BURNER UNITS (CONDENSING HHW BOILERS)

- A. General:
 1. Units shall be one of the following manufacturer's models with capacity and operating characteristics indicated on schedules: Lochinvar FTXL (Basis of Design) Aerco Benchmark, or Cleaver Brooks.
- B. Furnish units complete with boiler, burner, forced draft fan, combustion controls, safety controls, wiring, insulated jacket, boiler trim, drain valve, and assembled on structural steel base frame. Unit shall be ready for connection to fuel, electrical sources, and water piping.
- C. The boilers shall be installed on a concrete housekeeping pad of sufficient height (minimum 4" or higher) to allow the gravity draining of condensate liquids through the condensate trap, condensate neutralization unit, and height to allow gravity draining to the nearest floor drain.
- D. Boiler:
 1. Boilers shall be constructed and stamped in accordance with the latest ASME Code for 150 psi working pressure and must be inspected by Authorized Boiler Inspection Agency and registered with National Board.
 2. Combustion chamber shall be sealed and completely closed with ceramic fiberboard insulation.
 3. Boiler shall operate at minimum 97% thermal efficiency at 120°F return water temperature when fire tested at 100% of rated capacity and at a minimum of 93% thermal efficiency at 120°F return water temperature when fire tested at 25% of rated capacity.
- E. Burner:
 1. The boiler burner shall be capable of a minimum 7:1 turndown ratio of the firing rate without loss of combustion efficiency.
 2. Factory mounted and constructed of stainless steel or ceramic.
 3. Sealed combustion type suitable for firing LP gas. All fuel trains and controls shall conform to UL requirements, be designed in accordance with FM, and be factory assembled, wired, mounted and tested.

4. Unit manufacturer shall provide pressure regulators at each boiler to reduce LP gas pressure a suitable level for proper burner operation.
- F. Emissions
1. Boiler burner shall produce NOX emissions level of no more than 20 ppm corrected to 3% O₂.
- G. Electrical and Controls:
1. Furnish unit with electrical entrance cabinet, NEMA 1, to accept single service of 120 V, 1 Ph, 60 cycle power to accommodate motors and control circuit power. Furnish unit with control cabinet, NEMA 1A enclosure with lock and exterior resets for blower motor starter and flame failure.
 2. Boiler manufacturer shall furnish remote shutdown switch. Switch shall be red mushroom button or Push-to-Activate type with safeguard feature against tampering and easily readable identification marking. The switch is to be installed in a location that complies with code requirements.
 3. Control cabinet to include magnetic motor starters with thermal overload protection, electronic flame safeguard, programming timer for pre-purge and post-purge, burner switch, control circuit switch and fuse, necessary switching relays, low water and flame failure alarm, manual automatic selector switch, indicating lights for major operations, numbered terminal strips, numbered wiring and engraved nameplates.
 4. Controls shall include high limit (manual reset), operating limit (auto reset), frost control, high and low gas pressure switches, blocked condensate drain switch and combustion air switch.
 5. Controls to be interlocked to cause 100% automatic shut-off of fuel flow to burner in event of failure of electric power, burner flame, pilot flame, low water, combustion air, or any other condition, which might prove hazardous.
 6. Furnish unit with all necessary controls for fully-modulated firing with proved low fire start.
 7. Provide controls to restart automatically on emergency power or power restoration after power outage.
 8. Provide auxiliary contacts to allow the BAS to enable/disable the operation of the boilers and provide status and alarm indication to Building Automation System (BAS). Alarm condition shall be reported to BAS whenever alarm condition is indicated at boiler packaged control panel.
 9. Provide a BAS Gateway for a BACnet interface.
 10. Furnish unit with lead-lag and efficiency optimization sequence controls. The control panel with digital operating controls and LCD display shall be of controlling up to five boilers. The controller shall automatically control the operation of one or both boilers as needed to maintain the consistent supply temperature of the heating hot water system. The HHW system shall be a variable flow design with a BAS controlled bypass to maintain a minimum water flow through the HHW system.
 - a. Control shall include assured low fire cutoff.
 - b. Furnish temperature sensor required for boiler capacity control and flow sensor required for lead-lag control.
 - c. Boiler controller shall sequence lead-lag boilers to maintain supply temperature setpoint field-adjustable supply water temperature setpoint. Boiler controller shall operate as many boilers as possible any load at the lowest stable firing rate. Boilers shall be staged on, operating in parallel to maintain hot water supply temperature setpoint. Once all boilers are operating, boiler controller shall modulate firing rates in unison. A lag boiler shall be sequenced off and its associated isolation valve closed whenever firing rate falls below a field-adjustable threshold. Whenever a lag boiler is turned off, boiler lead-lag controller shall monitor supply temperature and firing rates of the operating boilers, and sequence the lag boiler(s) back on whenever that boiler can

- be activated without reducing firing rates of any individual boiler below a field-adjustable threshold.
- d. The boilers shall be furnished with motorized isolation valves and the boiler controls shall control the operation of the respective isolation valve for each boiler. An end-switch shall indicate the closed position of the valve to the boiler controls. The boiler shall not be allowed to operate when the valve position is closed.
 - e. Provide the remote access connectivity option (CON-X-US Lochinvar or equal).
- H. Insulation and Jacket:
1. Units shall be factory insulated with enameled steel jacket.
- I. Combustion Air Intake:
1. Use stainless steel duct for combustion air intake pipe; seal joints and seams with silicone caulk.
 2. When specifically allowed by the manufacturer of the condensing boiler, Schedule 40 Polyvinyl Chloride (PVC) Piping with ASTM D2665 solvent weld PVC fittings may be used for the outside combustion air intake in place of the metal ducting systems listed above.
 3. Combustion air intake and exhaust venting will be from the roof above the mechanical room (direct vent vertical) where the boilers are to be located. Roof openings and curbs to be coordinated with the architect.
 4. Provide manufacturer's transition or adapter as required for connection to combustion air intake pipe.
 5. Air intake piping shall be constructed of -4" pressure class as required in Section 23 3114 - Ductwork
- J. Venting:
1. Refer to Section 23 5100 – Smokestack, Breeching and Vent Piping for venting requirements.
 2. Boiler smokestack exhausts will be located above the mechanical room where the boilers are to be located. Roof openings and curbs to be coordinated with the architect.
- K. Boiler Trim (Each Boiler):
1. Furnish complete water trim including:
 - a. ASME Safety Relief Valve set according to the boiler's working pressure rating.
 - b. Combustion pressure-temperature gauge
 - c. Operating temperature controls
 - d. High limit control
 - e. Low Water Cut Out - LWCO to be operationally testable
 - f. Stack thermometer
 - g. Air pressure switch
 - h. Water flow switch
 - i. High gas pressure switch
 - j. Low gas pressure switch
 - k. Blocked condensate drain switch
 - l. Actuated isolation valves with end-switches
 - m. HHW system supply and return water sensors to be installed in wells by the mechanical contractor and connected to the boiler controller.
 - n. Individual boiler outlet water temperature sensors to be connected to the boiler controller.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install units as shown on plans, as detailed, and according to manufacturer's installation instructions.
- B. Install all items shipped loose by equipment manufacturer under supervision of equipment manufacturer's field service personnel.

- C. Provide all field electrical wiring required in this Section of the specification. Install wiring in metal conduit and in accordance with Division 26 of this Specification and applicable Electrical Codes.

3.02 BOILER-BURNER UNITS (CONDENSING HHW BOILERS)

- A. After piping system has been flushed, manufacturer shall provide test, start-up, and adjust procedure as recommended by boiler manufacturer.
- B. Manufacturer shall verify in writing that boilers have been cleaned according to their recommendations and are ready for operation.
- C. Pipe vents from gas train to atmosphere. Size of each vent shall not be less than connection size to device.
- D. Pipe boiler drains to nearest floor drains.
- E. Install gas pressure gauges at downstream of gas pressure regulators.
- F. Provide remote shutdown switches inside and outside of boiler room where shown and wire into boiler control/safety circuit to shut off fuel or energy supply when activated in accordance with ASME CSD-1.

END OF SECTION

**SECTION 23 7214
HEAT RECOVERY EQUIPMENT**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 23 7323 – Factory Fabricated Custom Air Handling Units
- B. Section 23 7400 - Packaged Rooftop Air Handling Units
- C. Section 20 0513 – Motors

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

- A. Shop Drawings including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Capacities/ratings/efficiencies
 - 3. Pressure/temperature rating
 - 4. Materials of construction
 - 5. Dimensions and weights
 - 6. All other appropriate data
 - 7. Rotor media test reports

1.04 CHECK, TEST AND START

- A. Rotary type heat exchanger manufacturer shall provide services of factory trained service engineer to supervise installation and start-up of heat exchangers, and to field measure purge air quantity, seal leakage and heat transfer efficiency. Service engineer shall also instruct Owner's representative in operation and maintenance of unit. Before acceptance by Owner, unit manufacturer's representative shall approve, and certify in writing, the complete installation including ductwork, wiring connections and proper functioning of all operational controls, and unit performance including heat transfer efficiency and air leakage quantities. Start-up shall not be performed until start-up date has been approved by Architect/Engineer.

1.05 WARRANTY

- A. In addition to standard warranty, provide factory trained service personnel one year after start-up heat recovery equipment to verify specified heat transfer efficiencies and specified quantities of purge and seal leakage.
- B. If at this time energy recovery equipment is not operating in strict accordance with above criteria, manufacturer shall repair or replace non-conforming equipment and/or furnish and install similar equipment and components to replace functions of heat recovery equipment.

PART 2 - PRODUCTS

2.01 AIR-TO-AIR HEAT EXCHANGERS (ROTARY TYPE ENTHALPY WHEEL)

- A. General:
 - 1. Manufacturers: Semco, Thermotech, Novelaire Flakt Woods or Klingenburg.
 - 2. Unit capacities, efficiencies and operating characteristics shall be as scheduled.
 - 3. The enthalpy wheel shall recover both sensible and latent heat and be AHRI 1060 certified.
 - 4. Refer to drawings for dimensions of unit.
 - 5. Units shall be complete with energy transfer wheels, permanently lubricated bearings, shafts, purge sectors, air-seals, wheel drive motors, motor speed reducers, drive belts, all enclosed in steel casing. Units shall be factory assembled, tested and shipped as one piece.
 - 6. Unit shall be capable of transferring sensible and latent heat at approximately the same efficiencies and be tested in accordance with ASHRAE 87-78P.

7. The ERM shall include economizer wheel bypass to reduce fan energy usage when energy recovery is not required.
 8. The energy recovery section shall feature a rotary energy recovery wheel mounted within a rigid, extruded aluminum framed module containing the wheel drive motor, drive belt, wheel seals, and maintenance free bearings. The module shall be able to slide out for servicing.
- B. Transfer Media:
1. Construct transfer media of non-asbestos material and in accordance with NFPA ruling, pass UL 900 flame and smoke tests.
 2. The enthalpy wheel shall recover both sensible and latent heat and be AHRI 1060 certified.
 3. The matrix shall be a minimum of 8" thick to achieve optimal performance and be constructed from a corrugated aluminum alloy. The corrugation shall be uniform to obtain minimum pressure drops through the wheel. Wheels with varying flute sizes are not acceptable. Wheels with non-metallic matrices will not be considered for this application.
 4. Wheel shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
 5. Design transfer media for laminar airflow and capability of passing solids up to 300 microns.
 6. Transfer media shall, when exchanging energy at efficiency listed in schedule, run dry to touch and not require condensate drain for summer or winter operation.
 7. Rotor media shall be made of aluminum, which is coated to prohibit corrosion. Media surfaces shall be coated with non-migrating solid absorbent layer prior to being formed to ensure that all surfaces are coated and that adequate latent capacity is provided.
 8. Construct rotor of corrugated aluminum treated with inorganic compounds and strengthened with radial spokes for rigidity. Desiccant coating shall be bacteriostatic, non-toxic and non-corrosive. Desiccant carryover shall be limited by coating surface of the aluminum wheel with a polymer coating.
 9. Desiccant media shall utilize a specifically treated and coated with Silica Gel desiccant to assist and enhance latent heat transfer or a 3A molecular sieve certified by manufacturer to have internal pore diameter distribution which limits absorption to materials not larger than critical diameter of water molecule, 3.0 angstroms. Rotor media shall be supplied with acid resistant face coating to prevent corrosion.
 10. Rotor media shall be provided in segments to allow for field erection or replacement of one section of media at a time without side access. No external pullers or other special tooling shall be required for field assembly or replacement. Media shall be machined to fit in between primary and secondary spoke and guiding flange of outside rim. Each media segment shall be compressed independently of other segments during manufacturing without causing any angular deformation and resulting misfits between spokes and media parts. Results shall be wheel with flatness of $\pm 1/32"$. No adhesive or silicone shall be necessary to secure media in place.
 11. The structural frame and casing shall be designed and manufactured to allow a maximum rotor deflection of $\pm 1/32"$, as measured at the outer radius, during maximum rated airflow and differential pressure conditions.
 12. Shaft shall be machined as to provide a shoulder against the bearings for a positive locked position to eliminate any lateral movement of the rotor due to axial bearing loads. Grease fittings shall be easily accessible.
 13. Rotor media shall be tested in accordance with ASHRAE Standard 84-91 and ARI Standard 1060-05 by a qualified independent testing laboratory. Testing shall confirm published performance and document that the desiccant material does not transfer pollutants typically encountered in the indoor air environment.
- C. Purge and Seals:
1. Furnish units with built-in purge sections, allowing maximum cross contamination of particulates of 0.2% and maximum exhaust air carryover of 0.04% by volume.

2. Provide casing seals on periphery of rotor, as well as on duct divider and purge section.
 3. Seals shall be adjustable and constructed on neoprene, held in place with clips fastened to stud welded bolts and compressed by retaining band. Required seal clearance shall be factory set and checked at installation.
 4. Rotor seal shall be Labyrinth non-contact seals. Multi-pass seal shall utilize 4 labyrinth stages for optimum performance. Seal system shall be able to withstand pressure differential up to 12" WG without deflecting or causing excessive air leakage. Seals shall be adjustable and set within 0.05" of rotor surface.
- D. Drive Assembly and Controls:
1. Units shall be capable of variable speed operation to maintain constant design or scheduled supply air discharge temperature.
 2. Manufacturer shall furnish units with all components necessary for control of variable speed operation including drive assembly. The control of the wheel drive shall be integral to the RTU controller. The ERM shall have a dedicated microprocessor controller that is networked to the packaged rooftop unit microprocessor controller.
 3. External tapered roller bearings with double set screw locking collars shall be provided and sized for a minimum L-10 life of 219,000 h of operation, and shall be changeable without complete disassembly of the rotor.
 4. Wheel speed shall not rotate faster than 20 RPM. Any rotational speed above 20 RPM will be unacceptable since this will reduce the efficiency of the purge section.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install units as shown on drawings, and in accordance with manufacturer's installation instruction.

3.02 AIR-TO-AIR HEAT EXCHANGERS (ROTARY TYPE)

- A. Provide solid air separation between the two air streams so that air leakage does not occur through casing. Adjust seals to recommended clearance before operating fans for any purpose.
- B. Provide proper filtration of all air streams to protect the operation and cleanliness of the energy recovery wheel.
- C. Adjust the wheel seals to provide the scheduled bypass air cfm.

END OF SECTION

**SECTION 23 7323
FACTORY FABRICATED CUSTOM AIR HANDLING UNITS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 20 0513 - Motors
- B. Section 20 0514 - Variable Frequency Drive (VFD) System
- C. Section 20 0529 - Mechanical Supporting Devices
- D. Section 20 0700 - Mechanical Systems Insulation
- E. Section 23 0550 - Vibration Isolation
- F. Section 23 0901A - Control Systems
- G. Section 23 2116 - Pipe and Pipe Fittings
- H. Section 23 2118 - Valves
- I. Section 23 2120 - Piping Specialties
- J. Section 23 3314 - Ductwork Specialties
- K. Section 23 3400 - Fans
- L. Section 23 4114 - Filters
- M. Section 23 7214 - Heat Recovery Equipment
- N. Section 23 8216 - Coils
- O. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables
- P. Section 26 0533 - Raceway and Boxes for Electrical Systems
- Q. Section 26 2726 - Wiring Devices
- R. Section 26 2816 - Enclosed Switches and Circuit Breakers
- S. Section 26 5000 - Lighting

1.02 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplemental Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

- A. Shop Drawings for all equipment including, but not limited to, the following:
 - 1. Appropriate identification
 - 2. Complete drawings showing plans and sections including details of construction
 - 3. Overall unit dimensions and individual components and sections dimensions
 - 4. Shipping and operating weight of unit and/or sections
 - 5. Structural design load
 - 6. Details of component support
 - 7. Capacities/ratings
 - 8. Materials of construction
 - 9. Thermal and acoustical performance of wall, roof and floor panels
 - 10. Pressure ratings and leakage ratings
 - 11. Thermal break construction details and performance calculations or test data
 - 12. Each component manufacturer's name, model number and data. (Refer to each component section for submittal requirements.)
 - 13. Air leakage rates and test data
 - 14. Wiring diagrams and terminal points for control panels provided with units
 - 15. Manufacturer's installation instructions
 - 16. Air handling unit manufacturer's local representative and phone number

1.04 DESIGN CRITERIA

- A. For housings and floors operating under positive pressure (fan discharge side), maximum allowable deflection shall not exceed 1/200th of any span in any direction at $\pm 10''$ WG.

- B. For housings and floors operating under negative pressure (fan inlet side), maximum allowable deflections shall not exceed 1/200th of any span in any direction at ± 10 " WG.
- C. Air handling unit manufacturer shall install all equipment furnished by others and provide all other equipment as specified to result in complete and operational unit. Unit manufacturer shall assume single source responsibility for all air handling unit components and accessories.
- D. Furnish units complete with factory controls, fans, piping, valves, piping specialties, actuators, motors, coils, compressors, refrigerant condensing equipment, energy recovery wheels, drain pans, filter sections, damper sections and interior lighting, meeting configuration and as shown on drawings, specified and scheduled. All unit components shall meet this Section of Specification and all requirements specified in each section and division listed under Related Work. Internal control dampers shall be provided by unit manufacturer. External control dampers and actuators shall be furnished by Control Contractor and shall be field-installed by Mechanical Contractor.
- E. All materials as applied shall meet NFPA 90A possessing flame spread rating of not over 25 and smoke developed rating of not over 50.
- F. Unless otherwise indicated, galvanized steel shall be G90 according to ASTM A924 (formerly ASTM A525), A653 and ASTM A-90 and aluminum sheet shall be 3003-H14 alloy, conforming ASTM B209.
- G. Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled static pressure without operating into motor service factor.
- H. Motor furnished with fan shall not operate into motor service factor in any cases.
- I. Where inlet and outlet ductwork at any fan is changed from that shown on drawings, submit scaled layout of the change and system effect factor calculations, indicating increased static pressure requirement as described in AMCA Publication 201. This Contractor shall be responsible for any motor drive and/or wiring changes required as result of duct configuration changes at fan.
- J. Air handling unit static pressure to take into consideration actual static pressure loss of components furnished within unit.
- K. Wire brush all welds with solvent and wipe clean all bare metal before painting.
- L. Air handling unit shall be constructed for outdoor application and shall be designed for roof mounting on concrete curb provided by GC. For outdoor units, allow for snow and wind loading in accordance with the governing building code when calculating allowable deflections.

1.05 FINAL CLEANING

- A. Outside and inside of each air handling unit shall be thoroughly cleaned. Use industrial grade cleaners to remove construction dust, sheet metal mill finish or grease. Unit openings shall then be covered with sheet metal or other proper material until ductwork is connected.

PART 2 - PRODUCTS

2.01 MANUFACTURERS (RTU-1)

- A. Annex Air (Basis of Design), Haakon, Temtrol, Climate Craft, Ventrol, Climate Craft with operating characteristics as scheduled and physical dimensions as shown on drawings and/or detailed.

2.02 UNIT BASE

- A. Unit base shall be fabricated from structural steel or fabricated steel.
- B. Weld steel solid at connection points to assure rigidity. Size perimeter steel to allow for rigging and handling.
- C. Locate and size base cross supports to support internal components.
- D. Add lifting lugs to perimeter steel along the longest length of unit or unit module. Incorporate means of attaching cable or chain into each lug.
- E. Lifting lugs shall be removable after placement of equipment.

- F. Base shall be split in maximum size pieces to allow for economical shipment to jobsite and placement within building. Provide bolting structural steel on both sides of split for field joining.
- G. Unit base shall be fully welded G-90 primed and finished with rust inhibiting epoxy paint.

2.03 UNIT FLOOR

- A. Unit floor shall be constructed to meet the maximum allowable deflection, but constructed of no lighter than:
 - 1. 16 ga plate of galvanized steel or 3/16" aluminum plate with diamond-tread.
- B. Floor joints and seams shall be sealed to meet allowable housing leakage rate specified. Use acrylic latex sealant meeting ASTM C834-76 (1981) or polyurethane sealant, ASTM C-920, Type S, Grade NS, Class 25, USDA Approved.
- C. Provide recessed drain pans as integral part of unit floor in cooling coils, pre-heating coils section. Entire floor including base drain pans shall be insulated on underside to have same thermal and acoustical performance specified for unit housing. Insulation shall be supported by minimum 20 ga galvanized steel liner with joints sealed to provide continuous vapor barrier.
 - 1. Drain pans shall be constructed from minimum 16 ga 304 SS sheet with 304 SS drain pipes.
 - 2. Drain pan shall be double sloped; pitched down in direction of air flow and pitched sideways to drain connection.
 - 3. Locate drain connections at lowest point of pan, one on either end. Connections shall extend through perimeter base channel and be continuously welded to insure air-tight seal as well as eliminate requirement for backup wrench during field piping. Provide removable cap on each drain connection.

2.04 UNIT HOUSING

- A. Unit housing shall be constructed of minimum 2" thick double wall panels meeting thermal, acoustical and structural requirements specified.
- B. Panels shall utilize modular panel type construction. Panels may be self-supporting with internal support structure or supported by structural frame work.
- C. Panel joints and seams shall be sealed with proper gasket and caulking to meet allowable housing leakage rate specified.
- D. Outer face of panels shall be constructed of no lighter than 16 ga galvanized steel and solid inner face of panels shall be constructed of no lighter than 20 ga G90 galvanized steel.
- E. Unit casing shall be insulated with minimum 2" thermos-composite foam with R-7 per inch foam insulation. Unit casing will have no exterior condensation at interior AHU temperatures down to 43F while unit exterior conditions are maintained at 95 F dry bulb / 85 F wet bulb.
- F. Use solid inner surface for all sections.
- G. Provide blank-off panels with proper gaskets and sealants to prevent air bypass around equipment such as filters, coils and energy recovery wheels. Blank-off panels shall be constructed of stainless steel no lighter than 16 ga unless otherwise noted. Blank-off panels at cooling coil sections shall be insulated with 3/4" thick insulation similar to AP Armaflex SA Duct Liner. Do not insulate blank-off panels between cooling coils located above drain pans.
- H. Panel Sound Transmission Loss in accordance with ASTM E90 shall equal or exceed the following:

	Octave Band Center Frequency (Hz)					
	125	250	500	1000	2000	4000
Transmission Loss (dB)	19	23	33	43	52	57

- I. Entire roof of outdoor units shall be constructed with standing seam water-tight joints and sloped 1/8" per foot.

2.05 ACCESS DOORS

- A. Each unit section shall have minimum 20" x 72" access door, unless otherwise specified or shown differently on drawings. Access doors for filter and coil sections shall be minimum 24" x 72".
- B. Fan section access door shall be sized to allow removal of fan wheel and motor through door, but not smaller than 30" x 72". If access door needs to be wider than 36", removable access panel may be provided.
- C. Access doors and door frames shall have similar thermal break construction as specified under Unit Housing.
- D. Access doors shall be same construction as housing panels.
- E. Access doors shall be guaranteed tight closing through use of seals around entire periphery. Provide neoprene gasket between door frame and housing for air tight seal.
- F. Each access door shall contain 1/4" thick wire glass or double glazed tempered glass window minimum size of 12" x 12" or 12" round. Window shall be double paned with vapor seal construction.
- G. Each access door shall be furnished with corrosion resistant metal hinges or continuous piano hinge and shall have at least 2 stainless steel or aluminum alloy handles operable from either side.
- H. Doors shall open against higher air pressure to effect seal.

2.06 REMOVABLE ACCESS PANELS

- A. Removable access panels shall be provided as indicated on drawings and where equipment removal is not possible through access door. Removable panels shall be same construction as housing panels.

2.07 WEATHER HOODS

- A. The outdoor intake weather hood shall be completely constructed in aluminum for corrosion resistance. The hood shall ship loose for field installation by the installing contractor. Painted galvanized hoods shall not be acceptable. The outdoor air hood shall be designed with a 4" extruded aluminum louver, bird screen and a plenum enclosure with drain holes. The louver blades shall be drainable type with a maximum 45-degree angle and curved with integral rain baffle. The louver design shall not allow more than 0.03 oz/ft² water penetration when tested in accordance to AMCA 500. The pressure drop of the complete hood assembly shall not exceed 0.05" wc at a maximum 500 fpm face velocity. A Pre-filter rack system shall be installed within the weather hood enclosure to prevent outdoor air dust and debris from entering the damper and unit casing plenum. Pre-filters installed inside the unit casing plenum and downstream of the outdoor damper will not be acceptable as this will increase overall maintenance on the damper, reduce indoor air quality and promote mold and bacteria growth. Filter access in the hood shall be accomplished via the louver that is installed with a stainless-steel piano hinge and spring loaded latch. No tools or ladders shall be required to access the pre-filters in the weather hood assembly.

2.08 FILTER SECTIONS

- A. Filters shall be provided as specified and scheduled. Holding frames shall be installed by unit manufacturer to raise filters off floor and to prevent leakage as specified by unit manufacturer.

2.09 REHEAT COIL SECTION

- A. Provide heating hot water reheat coils, piping and internal piping as specified and indicated on drawings.
- B. Terminate piping outside of unit casing for connection by Mechanical Contractor. Provide necessary pipe supports and hangers.
- C. Each coil shall be supported by galvanized steel frame which is independent of unit casing. Support frame shall allow individual coil removal. Coils shall be removable through unit access doors. Blank-off panels shall be galvanized steel sheets with insulation as specified.

2.010 ENERGY RECOVERY SECTION

- A. Refer to Section 23 7214 – Heat Recovery Equipment.
- B. The energy recovery section shall feature a rotary energy recovery wheel mounted within a rigid, extruded aluminum framed module containing the wheel drive motor, drive belt, wheel seals, and maintenance free bearings. The module shall be able to slide out for servicing.
- C. The energy recovery system shall include economizer wheel bypass dampers to reduce fan energy usage when energy recovery is not required. The air handler shall be furnished with an outside air intake enthalpy sensor that shall be connected to the unit controller to determine when the energy recovery wheel should be bypassed.
- D. Wheel shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
- E. The energy recovery system shall have a dedicated microprocessor controller that is networked to the packaged rooftop unit microprocessor controller.

2.011 AIR COOLED CONDENSING UNIT WITH VARIABLE SPEED COMPRESSORS

- A. Provide an integral air cooled condensing section with variable speed compressors. The condensing section shall be factory piped, wired, and charged with R-410A refrigerant. The section shall be from the same manufacturer as the air handling unit. Factory mounting and piping an air cooled condensing unit, provided by a third party is not acceptable. The, the exterior cabinet of the air-cooled section shall be of the same construction and paint color as the air handling unit. Compressors shall be variable speed scroll type that can modulate from 25% to 100% capacity per compressor. Variable capacity compressors which do not modulate the speed of the scrolls are not considered equal to a variable speed scroll since they consume more energy at the same capacity output. Mechanically stepped scrolls which are unloaded via a digital signal to a solenoid valve, in a timed sequence, will not be acceptable for this application. The variable speed scrolls shall be operated via a factory supplied variable speed controller per compressor, and all tandem compressors will modulate in unison. Using a single variable speed controller on the lead circuit alone is not efficient during part load conditions, therefore will not be acceptable for this application. Each compressor and controller assembly shall be equipped with the following features: permanent magnet motor, electronic expansion valve, a crankcase heater function, anti-short cycling, built-in phase loss detector, EMC filter, oil return management system, and reverse rotation protection. All refrigeration parts, including the compressor and the speed controller will be located in a closed and vented service compartment, separate from the condenser coil airflow. Compressors located in compartments open to the outside are not acceptable. Compressors shall be mounted on rubber isolators to limit vibration transmission and shall include flexible hoses on both the suction and discharge refrigeration lines. Flexible hoses shall be pressure tested up to 620 psig. All air cooled condensing units above 18 tons will have a minimum of two compressors. Condenser fans shall have 7 air foil type blades with external mounted asynchronous motors that are Class F insulated, IP54 and 100% variable speed. Each condenser fan bank shall be provided with a variable voltage controller which modulates via refrigerant head pressure control for superior part load performance. All the condenser fans in a fan bank shall modulate in unison for each respective circuit. Staging condenser fans are not an acceptable mode of control for head pressure control. Protective guards shall be included on all condenser fans, and condenser coils. The coil protective guards shall be ideal to keep coil at maximum operating performance, protect the condenser from hail damage and allow for easy cleaning with quick release latches. The condenser coils shall be micro-channel design for maximum efficiency performance, consist of a single pass arrangement with integral receiver, and be pressure tested at 650 psig. Coil construction shall consist of aluminum alloys for the fins, tubes and manifolds. Copper tube, aluminum fin condenser coils are not acceptable as they require more refrigeration charge for the same capacity output. The following components shall be included in each

refrigeration circuit: Liquid line filter dryer, hi and low-pressure switch, hi and low-pressure transducers, suction and liquid lines shutoff valves and suction line accumulators. In addition, refrigeration piping must use Shrader type connections for all components, including but not limited to valves and transducers. Under no circumstances shall the units leave the factory without a complete run test and a copy of the QC report shall be provided upon request. Minimum (5) five-year compressor warranties shall be provided. Hot Gas reheat coil shall be installed down stream of direct expansion coil. The control for the hot gas reheat shall be full modulation type for humidity control. Receiver shall be provided and installed to store excess refrigerant in part load operation. Coil shall be same construction as heat pump air side coil.

2.012 DX COIL SECTIONS

- A. Provide cooling coils, piping and piping specialties specified, and indicated on drawings.
- B. Terminate piping outside of unit casing for connection by Mechanical Contractor. Provide necessary pipe supports and hangers.
- C. Coils shall be factory installed in the unit. Coils shall be designed with respective circuits to match the design requirements. All coils shall have a distributor per circuit connection. Primary surface shall be round seamless (3/8" O.D.) copper tube staggered in the direction of airflow. Secondary surface shall consist of rippled aluminum plate fins for higher capacity and structural strength. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Casing shall be constructed of continuous 304 stainless steel. Coils shall be circuited for counter-flow heat transfer to provide maximum mean effective temperature difference for maximum heat transfer rates. Headers shall have intruded tube holes to provide a large brazing surface for maximum strength and inherent flexibility. The complete coil shall be tested with 315 pounds air pressure under warm water and be suitable for operation at 250 psig working pressures. Maximum finned coil height shall be 60" and shall not exceed 500 FPM face velocity. Drain pan shall be provided on cooling coils. Cooling coils shall sit on stainless steel tubular support rails, which shall stand a minimum of (2) two inches above the highest point of the floor drain pan. Stacked coils shall be provided for larger airflows and intermediate drain pans shall be provided for each coil bank. Drain pans shall be stainless steel with 1.5" stainless steel drain connections on one side only. Pan shall be sloped in two planes. All coils shall be certified in accordance with ARI standard 410.
- D. Each coil shall be supported by a 304 stainless steel frame which is independent of unit casing. Support frame shall allow individual coil removal. Coils shall be removable through unit access doors or removable access panels. Blank-off panels shall be 304 stainless steel sheet with insulation as specified.
- E. Each coil support shall include minimum 16 ga 304 stainless steel all welded condensate drain pan extending minimum 6", but no more than 12" downstream of coil face. Each drain pan shall have sufficient depth to hold condensate water but not less than 2". Drain pan shall be sloped in 2 directions (pitched down in direction of airflow and pitched sideways to drain connection) for self-drainage at minimum 1/4" per foot slope. Drain pan shall be individually piped down to drain pan located below, and bottom drain pan to be piped to hub drain at exterior of unit. Drain connection opening shall be flush with bottom of pan. Side pan connection located at lowest point of pan may be used only where bottom pan connection cannot be used. Drain pipe shall be 304 stainless steel with sufficient size, but not less than 1-1/2".
- F. Instead of drain pan under bottom coil, recessed pan, integral with unit floor may be used. It shall be constructed as specified above including thermal insulation and drain lines, and shall incorporate required drain trap height. The drain pan shall be of sufficient length downstream from the coil to collect all condensate water that leaves the cooling coil.

2.013 FAN SECTION

- A. Fan and motor shall be provided as scheduled and meet requirements of appropriate specification sections.
- B. Fan and motor shall be factory mounted on vibration isolation equipment meeting requirements of Section 23 0550 - Vibration Isolation. Vibration base shall include integral adjustable motor base.
- C. Vibration isolation base shall have seismic restraints capable of containing fan in all directions with up to 1G of force applied.
- D. Provide track in fan section suitable for use with trolley-type winch, to be used for removing fan motor. Track shall be centered with fan section access door.
- E. Unit manufacturer shall provide flexible connection between fan and discharge wall. Unit manufacturer shall provide 1 set of additional sheaves as required to balance unit. Installation of any additional sheaves shall be responsibility of Balancing Contractor.
- F. The fans shall be carefully positioned and installed at an optimal distance to respect uniform airflow across the heat exchanger & coil(s).
- G. Plenum Fans ER model: Fans shall be direct drive radial centrifugal fans with free running impeller.
- H. Fan array will require to be operated by one VFD per fan, and each fan shall be provided with a backdraft damper that shall close in the event of a fan failure. Individual fan VFDs are not required to be provided with bypass starters.
- I. Plenum fan shall come equipped with guard grilles for the air intake side.

2.014 DISCHARGE AIR SECTION

- A. Provide with framed discharge opening or spun bellmouth fitting conforming to size and configuration of the ductwork.

2.015 FLOOR OPENING PROTECTION

- A. Floor shall have safety grates using 1" x 1/8" steel bar stock on 1-1/4" center spacing. Grates shall have same finish as floor. Provide 1-1/2" lip of galvanized steel at entire perimeter of opening.

2.016 ROOF CURB

- A. Unit manufacturer shall furnish roof curb for RTU-1. Roof curb shall be 18" high and constructed from minimum 12ga galvanized steel. At each of 4 corners, curb shall be joined together with corner post that is welded to one section of curb and then field bolted to adjacent section. Wood nailer shall be attached to inside flange of curb for field attachment of flashing and roof membranes.
- B. Roof curb and anchoring system shall be designed to comply with state and local building and wind load requirements.
- C. Curbs to be approved by National Roofing Contractors Association and shall be designed to meet local and state wind load requirements.
- D. Insulation: The roof curb shall be fully insulated with 1-1/2 inch, 3 lb. density acoustical and thermal insulation. The insulation shall be fiberglass with a foil face.
- E. Gasketing: Curb gasketing shall be furnished with the curb and is to be affixed to the curb immediately before mounting of the rooftop unit to provide an air seal.

2.017 CONTROLS

- A. The unit shall be delivered with factory installed control system. Under no circumstances shall the unit controls be provided by other than the manufacturer of the AHU equipment. Field installed control package will not be acceptable. The control system shall consist of a microprocessor with LCD display, 7-day time clock, 20-day holiday schedule, occupied/unoccupied mode switch, warm up mode, cool down mode, hi-lo limit discharge control, fan status, temperature and humidity sensors when applicable, scroll buttons to change

settings as required and alarm history. The control system main purpose will be as specified on the Sequence of Operation.

- B. Supply air temperature and humidity sensors shall be provided and be field mounted in the supply duct and wired by others. Space temperature and humidity wall mount sensors shall be provided, field mounted and wired by others as part of the BAS controls. Terminals for remote control shall be provided for entire unit ON/OFF, OCCUPIED/UNOCCUPIED mode selection and alarm contact. Refer to the Sequence of Operation and control schematic for detailed description and options.
- C. The control microprocessor shall communicate with the BAS with a Bacnet MS/TP interface.
- D. Control devices, will be furnished by Control Contractor and shall be factory installed by unit manufacturer as shown on plans and as described in control section of specifications.
- E. Control devices will be provided by Control Contractor. Unit manufacturer shall coordinate with Control Contractor and provide sleeved openings on unit housing for control devices as required and as shown on drawings.
- F. VFDs - VFDs will be used to set or regulate the fan speed and airflow for these units. The VFDs will modulate fan speed to maintain setpoint duct static pressures as measured by duct mounted pressure sensors. The VFD shall also have PID function for constant flow applications. The VFDs will be installed with integral brake transistor, overload protection, and adjustable pulse-width modulation (PWM). The VFD shall use Insulated Gate Bipolar Transistor (IGBT) technology to convert three phase input power to coded PWM output and have 4-20mA analog output terminals that are fully programmable for variable flow applications. The VFD shall be equipped with a keypad with status indicators, easy access functions, and monitoring functions during motor operation. In the event of a momentary power failure or fault the VFD shall read the inverter speed and direction of a coasting motor and shall automatically restart the motor smoothly. Technical support will be provided by the VFD manufacturer. VFDs shall be installed as shown on drawings with contactors, relays, and all specified accessories. Fan array VFDs will be installed without a bypass.

2.018 TESTING

- A. Owner and/or Owner's representative may elect to witness tests. Notify Owner and/or Owner's representative of test date at least 2 weeks in advance. Submit certified test data to Engineer for approval.
- B. Unit manufacturer shall provide factory tests to verify casing leakage after units are assembled.
- C. Unit manufacturer and installing contractor shall jointly provide field tests to verify casing leakage after units are installed at jobsite. Coordinate with Electrical Contractor for power to unit test fan.
- D. Casing leakage tests shall verify that unit casing leakage is less than 1% of design air flow at 10" WG static pressure.

2.019 ELECTRICAL SERVICE

- A. Provide adequate lighting and switching so equipment can be observed and maintained in safe manner. Combination lighting and convenience outlet circuit is required for each section of unit. Each access section shall contain a minimum of one light fixture. Sections wider than 12 ft shall have multiple light fixtures with maximum spacing of 6 ft.
- B. Lights, switches, convenience outlets, wiring and conduit shall meet requirements of appropriate specification sections of Division 26.
 - 1. Provide one central light switch with pilot light for all sections. Locate switch near power connection point.
 - 2. Provide timer for light switch to automatically turn off lights after preset time. Timer shall be similar to Intermatic Model FF2H with 0-2 hr range and hold feature to override automatic shut-off function.

- C. Wiring and conduit inside of unit shall be provided by unit manufacturer meeting requirements of appropriate Specification Sections of Division 26.
 - 1. Provide junction box for each fan motor at outside of unit wall for 3-phase, 480 V power connection and separate junction box for single-phase, 120 V power connection.
 - 2. Provide two points of power connection, one for 3-phase, 480 V and one for single-phase, 120 V power connection.
- D. POWER AND SAFETY CONTROL
 - A. The power and control center shall be integral to the unit housing and rated equivalent to NEMA 3R. Under no circumstances shall any wiring or parts be field installed. Panels that are externally mounted to the unit shall not be accepted, regardless of the NEMA rating they may have. A separate access door shall be provided with an approved locking device. All electrical components contained in the panel shall be UL/CSA certified and labeled. The unit shall be complete with VFDs, fuses, overloads; one VFD per fan w/backdraft isolation dampers on the fan inlets, relays, phase protection for compressorized units, terminals for main ON/OFF and step-down transformer. All components shall be factory wired for single point power connection by the manufacturer of the unit. A non-fused safety disconnect switch shall be factory installed for ON/OFF servicing. An electrical pipe chase for power and control feeding shall be provided next to the control panel. Any power or control wiring that is field installed shall not be accepted under any circumstances. The Short Circuit Current Rating (SCCR) is 5kA rms symmetrical, 600V maximum.

2.020 UV (ULTRA VIOLET) - C EMITTERS:

- A. Manufacturers: Steril-Aire, Inc., UVDI, or American Ultraviolet. Assembly shall be equal to Steril-Aire Model DE.
- B. Provide UVC emitters at downstream side of coiling coils and above drain pans in air handling units as scheduled to control airborne and surface microbial growth and transfer.
- C. Emitters shall comply with UL Standard 1995 as applicable to usage of UVC emitters in HVAC equipment.
- D. Emitters shall be independently tested under typical HVAC conditions and in accordance with ANSI/ASQCZ1.4. Total output per 25 mm(1") arc length shall not be less than 9 $\mu\text{W}/\text{cm}^2$ at one meter in 2.0 m/s(400 fpm) airstream of 32°C(50°F) air.
- E. UVC emitter and fixture shall consist of housing, power source, reflector, emitter sockets and emitter tube and shall be constructed to withstand HVAC environments.
- F. Housing shall be constructed of 304 or 316 stainless steel with 13 mm(1/2") electrical knockouts on both ends to simplify gang wiring and wiring to power. It shall incorporate components into one integral assembly that maximizes serviceability and radiant flux.
- G. Reflector shall be constructed of heavy gauge, spectral finished aluminum alloy with minimum 85% reflectance at 254 nm UVC energy.
- H. Emitter shall be of high output, hot cathode, T5 (15 mm) diameter, medium bi-pin type, capable of producing 95% of energy at 254 nm in air flow velocity to 5.0 m/s(1000 fpm) at temperature of 1°C to 66°C(35°F - 150°F). UVC emitters shall produce no ozone or other secondary contamination. Useful emitter life shall not be less than 9000 h, with no more than 40% output loss at end of one year of continuous use.
- I. Irradiance: Provide UVC lamps and fixtures in sufficient quantity to irradiate coil surfaces and air stream with no shadows and with minimum UVC irradiance at every point along face of coil at not less than 1225 $\mu\text{W}/\text{cm}^2$ at design cooling conditions with bulb mounted 300 mm(12") from coil face.
- J. UVC Monitoring: Provide NIST traceable UV Radiometer consisting of solid state photodiode UV sensor and externally mounted controller with visual indicators of UVC output and contacts for BAS communication. Controller must have ability to read real-time UVC energy levels by display module with minimum 89 mm(3.5") digit LCD screen/panel. Irradiance range shall be 0-

1999 (x10) $\mu\text{W}/\text{cm}^2$ with resolution of 10 $\mu\text{W}/\text{cm}^2$. Calibration wavelength shall be 254 nm with accuracy $\pm 10\%$.

2.021 PIPED SERVICE

- A. All piping and equipment installation shall be complete. Piping shall be installed and tested per appropriate specification section. Unit manufacturer shall be responsible for any leaks, which occur in unit during system testing which occurs before system startup.
- B. AHU manufacturer to provide an internal pipe chase for HHW piping to enter the casing through the inside of the roof curb.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Units shall be assembled in modules in unit manufacturer's plant to allow for testing of complete unit.
- B. Unit manufacturer shall supervise and be responsible for all field joining of the modules, including sheet metal, electrical and piping. Local trades may provide labor for unit assembly and installation.
- C. Joints in floor between modules shall be air and water tight.
- D. Unit manufacturer shall provide and install all equipment within unit as specified including fans, motors, coils, humidifiers, dampers, sound attenuating devices, piping, piping specialties, ductwork specialties, lights, switches and all equipment necessary to complete air handling equipment contained within housings. Mechanical and electrical connections (i.e., piping and conduit) shall be stubbed through housing so that appropriate contractor may provide service to air handling unit. Electrical wiring and control wiring shall terminate in junction boxes on accessible side of unit.
- E. Provide structural steel sub-base as required. Refer to Unit Base in Part 2.
- F. Field mounting of any equipment on housing walls or roof is not allowed without prior approval of Engineer.
- G. Unit manufacturer and Installing Contractor shall coordinate with other trade Contractors, all necessary requirements to assure proper air handling unit installation.

3.02 PROTECTION OF OPENINGS

- A. Protect openings on housings during construction against entry of foreign matter and construction dirt.

3.03 FIELD TESTING

- A. Unit manufacturer and Installing Contractor shall jointly perform field casing leakage tests on each completed housing assembly as previously specified and shall be responsible for repair of all leaks. Submit certified test data to Engineer for approval.

3.04 UVC EMITTERS

- A. Install UVC Emitters at outlet of cooling coils and above drain pans in accordance with manufacturer's instructions of installation, placement, wiring and testing.
- B. Provide interlock switch on access door to UVC Emitters to turn Emitters off when access door is opened.

END OF SECTION

SECTION 23 74 00
PACKAGED ROOFTOP AIR HANDLING UNITS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 20 0513 – Motors
- B. Section 20 0514 – Variable Frequency Drive (VFD) System
- C. Section 23 0550 - Vibration Isolation
- D. Section 23 7214 – Heat Recovery Equipment
- E. Section 23 0901A – Controls Systems

1.02 SUBMITTALS

- A. Shop Drawings including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Identification as referenced in the documents
 - 3. Capacities/ratings
 - 4. Materials of construction
 - 5. Inlet and discharge sound power levels
 - 6. Filters; size, efficiency
 - 7. Fans; type, drives
 - 8. Motor data (refer to Section 20 0513 - Motors)
 - 9. Power and control wiring diagrams
 - 10. Vibration isolation furnished with units
 - 11. Dimensions and weights
 - 12. Manufacturer's installation instructions
 - 13. All other appropriate data
- B. Fan curves shall include a series of curves indicating relationship of cfm and static pressure for various rpm and brake hp curves. Indicate design operating point clearly on fan curves.

1.03 DESIGN CRITERIA

- A. Design units specifically for outdoor rooftop application.
- B. Units to be completely factory assembled and run tested, piped, internally wired, fully charged with refrigerant and compressor oil when specified, and shipped in one piece. Provide factory wired non-fused disconnect switch.
- C. All units shall be factory run tested to check cooling operation, fan and blower rotation and control sequence.
- D. Furnish units complete with all components, accessories, and operating and safety controls to provide the intended performance as specified in this section, as shown on drawings and/or as scheduled.
- E. V-belt drives shall be designed for 150% of motor rating.
- F. Insulation and liners to meet NFPA-90A requirements.
- G. Unit shall be UL Listed and carry UL Label.
- H. Cooling and/or heating coils to be rated in accordance with AHRI Standard 410.
- I. Each fan and motor combination shall be capable of meeting both of the following conditions while maintaining stable fan performance:
 - 1. Deliver 110% of air quantity scheduled at scheduled static pressure.
 - 2. Unit static pressure shall take into consideration actual static pressure loss of components furnished within unit.
- J. Fan motor shall not operate into motor service factor in any case. Drive efficiency shall be considered in motor selection according to manufacturer's published recommendation, or according to AMCA Publication 203, Appendix L.
- K. Where inlet and outlet ductwork at any fan is changed from that shown on the drawings, submit scaled layout of the change and system effect factor calculations, indicating increased static

pressure requirement as described in AMCA Publication 201. This Contractor shall be responsible for any motor, drive and/or wiring changes required as result of duct configuration changes at fan.

1.04 TEST REPORTS

- A. Manufacturer or manufacturer's representative shall field check, test and start all units after they have been properly installed. Component systems to be run and adjusted to perform quietly and efficiently at capacities scheduled.
- B. Manufacturer or his representative shall provide services to field instruct and check unit operation and control of complete system. Instruction shall not take place until HVAC system has been field checked, tested, started and balanced. Manufacturer shall establish instruction dates, and give Engineer and Owner 10 days written notice of the time. Instruction shall be deemed completed when affidavit of instruction has been signed by representative of manufacturer and Owner.

1.05 OPERATION AND MAINTENANCE DATA

- A. Refer to Section 20 0000 - General Mechanical Requirements

1.06 GUARANTEE

- A. Manufacturer and Contractor shall provide an extended warranty on rooftop units for a period of 5 yr after acceptance by Owner.
- B. Warranty shall include all cost of parts and labor for any and all work unit manufacturer and/or contractor has to accomplish to repair malfunctioning unit or piece of equipment furnished by unit manufacturer. Warranty shall not cover normal maintenance such as changing of filters, cleaning of coils, and replacement of belts and lubrication of bearings.

PART 2 - PRODUCTS

2.01 PACKAGED ROOFTOP AIR HANDLING UNITS, (RTU-2)

- A. Manufacturers:
 - 1. Modine, Aeon, Addison, Valent, or Desert Aire
 - 2. Equal to manufacturer's model with capacity and operating characteristics as scheduled.
 - 3. Provide manufacturer's non-prorated five-year extended warranty.
 - 4. Packaged rooftop unit shall include complete system controls, motor VFDs, electric heating section, refrigerant cooling, hot gas reheat section, filters, supply fans, dampers, exhaust fans, and energy recovery wheels as scheduled.
 - 5. Unit shall be provided with bottom discharge and exhaust/return air openings as shown on plans. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
- B. Casings:
 - 1. Casing, access doors, and roof shall be completely weatherproof and constructed of heavy 18-gauge exterior, 20-gauge interior, double-wall galvanized or phosphatized zinc-coated steel with baked enamel finish and thermal break design at panel frames, joining mullions, base, corners, and access doors.
 - 2. Casing panels, access doors, and roof shall be insulated with 2-inch thick, 2 pound per cubic foot glass fiber or rigid polyurethane foam insulation. Casing panels, access doors, and roof shall have minimum thermal resistance of R-13. All products as applied shall meet the requirements of NFPA 90A, possessing flame spread rating of not over 25 and smoke developed rating of not over 50.
 - 3. Access doors shall be provided for access to filters, dampers, coils, fans, energy recovery wheels, and electrical and controls components. Access doors shall be double wall, heavy gauge galvanized steel complete with full-length corrosion-resistant piano hinges and stainless steel, aluminum, or zinc fasteners to secure door. Access doors and removable panels shall have neoprene gaskets.

4. Cabinet base to be constructed to mate and seal with the roof mounting curb. Provide sealing gasket for positive, waterproof seal when unit is installed on curb.
 5. Unit roof shall be sloped for positive drainage.
 6. Furnish access doors, exhaust and outside air hoods with rain gutters to protect openings.
 7. Outside air openings shall be provided with 1-inch aluminum mesh screens and rain hoods to prevent entry of water.
- C. Supply and Return/Exhaust Fans:
1. Backward curved plenum type with adjustable motor sheaves, statically and dynamically balanced and factory tested.
 2. Entire fan and drive assemblies to be mounted on a common base and be completely isolated from the unit by factory mounted vibration isolators.
 3. Mount fan wheels on solid steel shafts having self-aligning 200,000 h average life permanently lubricated bearings.
 4. Fan motors shall be Open Drip Proof (ODP), inverter duty rated for use with Variable Frequency Drives (VFD), and shall meet the requirements of Section 20 0513 - Motors. Motor horsepower and voltage shall be as scheduled.
 5. VFDs furnished shall meet the requirements of Section 20 0514 Variable Frequency Drives.
- D. Return-Exhaust Air Section:
1. Unit shall include 100% outside air economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return actuator. Unit shall include outside air opening bird screen, outside air hood, and barometric relief dampers.
- E. Filters:
1. Filters to be integral part within unit and to be easily accessible from unit via hinged access doors.
 2. Filters to be of size, thickness, and capacity scheduled.
 3. Unit shall include 2-inch or 4-inch thick, filters with a MERV-11 rating for all outside air intake and return air filters ahead of the energy recovery wheel, and a MERV-13 final filter upstream of the cooling coil and the energy recovery wheel.
 4. Unit shall include a clogged filter switch and a Magnehelic gauge mounted in the controls compartment.
 5. In addition, furnish 2 sets of filters to be used during construction and initial startup periods.
- F. Energy Recovery Sections
1. Refer to Section 23 7214 – Heat Recovery Equipment.
 2. The energy recovery section shall feature a rotary energy recovery wheel mounted within a rigid, extruded aluminum framed module containing the wheel drive motor, drive belt, wheel seals, and maintenance free bearings. The module shall be able to slide out for servicing.
 3. The ERM shall include economizer wheel bypass to reduce fan energy usage when energy recovery is not required.
 4. Wheel shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
 5. The ERM shall have a dedicated microprocessor controller that is networked to the packaged rooftop unit microprocessor controller.
- G. Refrigerant Cooling:
1. Direct expansion type, factory charged with R-410A refrigerant and fully tested. System to include refrigeration compressors, evaporator coil, air cooled condenser assembly, thermal

- expansion valves, liquid line valves, sight glass, filter drier, liquid and suction line service valves, and insulated interconnecting refrigerant piping.
2. Evaporator coils to be of non-ferrous construction with seamless copper tubes mechanically bonded to configured aluminum fins mounted in a 304 stainless steel frame. Furnish adequate refrigeration circuits, each with thermostatic expansion valve and solenoid valve for proper system part load operation.
 3. Furnish unit with fully insulated drain pan fabricated from minimum 16-gauge 3014 stainless steel with an additional coat of insulating sealer. Extend drain pan into fan section.
 4. Compressor to be hermetic scroll, or semi-hermetic type, designed to operate 1750 rpm.
 5. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
 6. Unit shall include a variable capacity scroll compressor on the lead refrigeration circuit which shall be capable of modulation from 25-100% of its capacity.
 7. Condenser coils shall be seamless copper tubing mechanically bonded to heavy-duty configured aluminum fins. Condenser coils of aluminum tubes and aluminum fins constructed with Microchannel coil technology will be acceptable. Condenser fans to be propeller type with exposed fan and shaft surfaces suitably weatherproofed. Fan motors to be furnished with normal and current overload protection.
 8. Refrigeration operating on safety controls to include high and low pressure cutout, oil pressure cutout, non-recycling pump down; manual lockout reset relay, compressor overload protections, magnetic contractors and low voltage control transformer.
 9. Furnish each unit with fully automatic compressor cylinder unloading capacity control system.
 10. Lead refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
 11. Vibration Isolation: Compressor(s) shall be mounted on the compressor manufacturer's recommended rubber vibration isolators to reduce transmission of vibration to the building structure.
 12. Internal Overload Protection: Compressor(s) shall include internal thermal overload protection to protect against excessive motor temperatures.
 13. Crankcase Heater: Compressor(s) shall include a crankcase heater to protect against liquid flood-back and the elimination of oil foaming on startup.
- H. Condensers:
1. Weatherproof vertical discharge, direct drive propeller condenser fans with permanently, lubricated ball bearings and built-in thermal overload protection.
 2. Condenser fans shall be VFD driven variable speed for condenser head pressure control. Factory provided and factory programmed VFDs shall continuously modulate the fan air flow to maintain head pressure at acceptable levels. Cooling operation shall be allowed down to 35°F with adjustable compressor lockouts.
 3. Coils shall be multi-pass and fabricated from aluminum microchannel tubes or coils shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings.
 4. Condenser Coil Orientation: The condenser coil shall be sloped approximately 60° from horizontal to protect the coil from hail damage.
 5. Condenser Coil Coating: The micro-channel aluminum fin/tube condenser coil will have a flexible epoxy polymer e-coat uniformly applied to all coil surface areas with no material bridging between fins. The coating process will ensure complete coil encapsulation and a uniform dry film thickness from 0.6 – 1.2 mils on all surface areas including fin edges and

meet 5B rating cross-hatch adhesion per ASTM B3359-93. Corrosion durability will be confirmed through testing to no less than 5,000 hours salt spray resistance per ASTM B117-90 using scribed aluminum test coupons. Coils subjected to ultraviolet (UV) exposure will receive a spray-applied, UV-resistant urethane mastic topcoat to prevent UV degradation of epoxy e-coat film.

- I. Electric Heating Section:
 - 1. The heating section shall be complete with fuses, a high temperature limit switch, and fully modulating SCR (Silicon Controlled Rectifier) capacity control. An airflow proving switch is monitored to ensure proper airflow before the heating circuit is energized.
- J. Dampers
 - 1. Provide factory mounted and wired motorized isolation dampers for return air, outside air, and exhaust air streams. Damper assemblies shall have extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall have maximum leakage of 4 cfm per sq. ft. of damper area when subjected to 1 inch WG air pressure differential across the damper. Damper assembly shall be controlled by spring-return fail closed actuator and a field wired control signal.
- K. Roof Mounting Curbs:
 - 1. The unit shall be supplied with a fully assembled, field installed roof curb with welded mitered corners and internal support channels. Construct roof mounting curb to mate and seal with unit casing base. Curb to have minimum height of 18".
 - 2. Construct curb to support perimeter of entire unit. The curb shall be constructed of 14 gauge G90 galvanized steel and include 1" x 4" pressure treated wood nailing strips and 20 gauge galvanized steel sheet metal flashing. Form cross section of curb members to accept wood nailing strips and insulation. Form top curb members to provide counter flashing. The curb shall be designed for the pitch of the roof on which the unit is to be installed to provide a level unit.
 - 3. Curbs to be approved by National Roofing Contractors Association and shall be designed to meet local and state wind load requirements.
 - 4. Insulation: The roof curb shall be fully insulated with 1-1/2 inch, 3 lb. density acoustical and thermal insulation. The insulation shall be fiberglass with a foil face.
 - 5. Gasketing: Curb gasketing shall be furnished with the curb and is to be affixed to the curb immediately before mounting of the rooftop unit to provide an air seal.
- L. Electrical:
 - 1. Furnish each unit with factory mounted disconnect device with short circuit and over current protection, and variable speed drives.
 - 2. Power Connections: Control center shall be constructed to permit single-point high voltage power supply connections.
 - 3. Wire Management: All wiring is to be run in conduit that is located between the unit ceiling liner and roof casing with drops from the ceiling to keep wires clear of other internal components, prevent accidental damage to wiring during service, and improve cleanliness of unit interior.
 - 4. Wiring Diagram: The unit shall have a job specific wiring diagram affixed to the interior of the control compartment access door.
 - 5. Convenience Outlet: Unit shall be provided with a factory installed and wired 115 volt, 13 amp ground fault service receptacle mounted on the exterior of the unit casing and powered by a 1.5kVA transformer with disconnect switch in the unit control panel.
 - 6. Motor horsepower and voltages shall be as scheduled.
 - 7. Unless otherwise indicated, units consisting of multiple fans and motors shall be factory pre-wired with the components listed herein. Each unit shall be designed to accept a single-point power connection for incoming line voltage power wiring.

8. Phase/Voltage Failure Relay: The unit shall be provided with an internally mounted phase measurement relay to monitor the 3-phase power supply for phase sequence, phase failure, asymmetry, under voltage and overvoltage.
 9. Provide a NEMA 4X gasketed enclosure in a readily accessible location on the exterior of the unit. The enclosure shall contain:
 - a. Power distribution block(s) configured to accept a single-point power connection.
 - b. Wiring and additional power distribution block(s), as required, to break out the single-feeder incoming power wiring into multiple branch feeders to the multiple motors.
 - c. Equipment grounding bus or lug.
 - d. Factory Installed Deadfront Disconnect Switch: Unit shall be provided with a factory installed and wired, dead-front, non-fused disconnect switch.
 - e. Separate motor branch circuit disconnect for each motor. Disconnects shall have permanent provisions for padlocking in the OFF position.
 - f. Provide engraved, laminated plastic nameplate on cover of enclosure to identify motors served. Attach using screws or rivets; do not use adhesive.
 10. Each branch feeder to an individual fan motor shall be designed and equipped to comply with the requirements of Article 430 of the National Electrical Code including:
 - a. Motor circuit conductors – Article 430.21.
 - b. Motor and branch-circuit overload protection – Article 430.32. Provide a separate overload device for each motor as required.
 - c. Motor branch-circuit short-circuit and ground fault protection – Article 430.51.
 - d. Motor overtemperature protection – Article 430.126. Provide separate overtemperature protection for each motor as required.
 11. Overload and overtemperature devices may be contained in the enclosure described above or elsewhere in the unit as determined by the manufacturer.
 12. Label all wiring and power distribution block positions according to factory wiring diagram furnished with unit.
 13. All motor wiring for the unit fan section shall be completely pre-wired within unit at factory. The only field wiring connection required shall be the incoming line voltage power wiring to a single-point connection in the electrical enclosure.
- M. Unit Controls:
1. Integral Factory-Provided Controller:
 - a. Unit controller shall be capable of controlling all features and options of the unit. The programmable microprocessor controller shall be factory installed in the unit controls compartment and factory tested. Controller shall be capable of standalone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
 - b. Control Panel: All components located in the panel shall be clearly marked for easy identification. All terminal blocks and wires shall be individually numbered. All electrical wires in the control panel shall be run in an enclosed raceway.
 - c. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
 - d. The controller shall monitor output from sensors within each unit subsystem and automatically adjust operating parameters to maintain programmed setpoints, strategies and sequences. The controller will be programmed to operate the unit in an energy efficient manner using pre-engineered control strategies.
 - e. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
 - f. Cooling capacity shall modulate based on supply air temperature.

- g. With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet outside air humidity loads and prevent supply air temperature swings and overcooling of the space.
 - h. Heating capacity shall modulate based on supply air temperature.
 - i. The controller shall contain LED's and/or LCD interface to indicate the power status, communications status, and fault conditions that arise during operation. Fault conditions indicated include but are not limited to supply air sensor failure, outdoor air sensor failure, space sensor failure, mechanical cooling failure, mechanical heating failure, low supply temperature alarm, high supply temperature alarm, and control temperature cooling or heating failure. The controller shall also monitor outside temperature for heating and cooling circuit lockout during mild conditions. If temperatures fall below the low supply temp alarm point, the unit shall be shut down.
2. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a BACnet network.
3. Damper Controls: The damper controls subsystem shall be controlled by the microprocessor controller.
4. Variable-air-volume (VAV) Control for Supply and General Exhaust Fan Control:
 - a. Control fan VFD to maintain duct static pressure setpoint(s).
 - b. Provide duct static pressure sensors with 0-5 VDC output and 0-5" WG range.
 - c. The variable frequency drive will operate the supply fan at a reduced speed during energy recovery wheel economizer by-pass operation. The reduction in fan speed during economizer bypass mode is to prevent a significant increase in airflow from the reduction in system static pressure when the supply air by-passes the energy recovery wheel.
5. Temperature Controls: The temperature controls subsystem shall be controlled by the microprocessor controller as follows:
 - a. Supply Air Temperature Control – The controller shall monitor and control the supply air temperature to maintain the desired supply air temperature.
 - b. Dehumidification Control based on Outside Dewpoint – The controller shall monitor an outside temperature/humidity sensor and enter dehumidification mode if the outside air dew point exceeds the desired setpoint. In dehumidification mode, the controller shall monitor an evaporator coil suction line pressure sensor and calculate corresponding coil temperature. The controller shall then modulate the digital scroll compressor to maintain the desired coil temperature, based on suction line pressure, necessary to increase latent heat (moisture) removal. The hot gas reheat option is highly recommended to avoid overcooling the space.
 - c. When equipped with the hot gas reheat option, the controller shall monitor a factory supplied, field installed supply air temperature sensor and control the modulating hot gas reheat valve to vary the flow of hot condenser gas through the reheat coil to maintain the desired supply air temperature setpoint and prevent temperature swings and overcooling of the space during dehumidification.
 - d. The controller shall monitor the outside air temperature sensor and lockout each compressor at a preset adjustable temperature setpoint.
6. Energy Recovery Controls: The energy recovery controls subsystem shall be controlled by the microprocessor controller as follows:

- a. The energy recovery module wheel operation is controlled to rotate when energy recovery is maximized without causing a rise in latent loading to the mechanical cooling equipment.
 - b. Economizer Bypass: The module shall include an economizer wheel bypass damper. To maximize energy recovery effectiveness, the energy recovery module bypass damper is closed when the wheel is rotating and to minimize supply fan energy consumption, the damper is open when the wheel is not rotating.
 - c. Economizer Bypass Jog Mode: The module shall include energy recovery wheel start-stop-jog control to periodically rotate the wheel position during economizer mode to avoid wheel contamination from the airstream.
 - d. Wheel Defrost Mode: The module shall include energy recovery wheel defrost control to periodically stop the wheel rotation to allow the warm exhaust air to defrost the wheel.
 - e. Wheel Preheat: The energy recovery module shall include an optional electric preheat element. The control shall cycle the preheat element on or off based on the outside air temperature and indoor air temperature and relative humidity to ensure the temperature to the wheel exceeds the frost threshold setpoint.
 - f. Wheel Rotation Sensor: When equipped with the optional wheel rotation sensor, the main unit controller shall monitor the sensor and initiate an alarm signal if wheel rotation is not sensed when energized.
 - g. Wheel Pressure Drop Switch: When equipped with the optional wheel pressure drop switch, the main unit controller shall monitor the switch and initiate an alarm signal if the wheel pressure drop exceeds the switch setpoint of the switch. The wheel pressure drop can rise if the wheel is excessively dirty or if the wheel has frosted.
7. Make-up Air Control, For Return-Air Units
- a. Provide return air dampers, sensors, and controllers as required to control return air flow.
 - b. Unit shall modulate heating, cooling, and return air flow with variable outside air flow to meet ventilation outside air loads. Cooling capacity shall modulate based on supply air temperature.
 - c. Unit shall efficiently modulate cooling, return air, hot gas reheat and the internal reheat system, to meet space temperature and humidity loads and prevent supply air temperature swings and overcooling of the space. Space temperature and humidity sensors shall be provided.
 - d. The unit controls shall also monitor the outside air temperature and humidity conditions, the unit discharge supply air temperature, filter differential pressure, and refrigerant suction pressure.
8. Controls for 100% Outside Air Lab Units:
- a. Unit shall control the heat recovery wheel and general exhaust fan to provide exhaust system pressure and flow capacity to the air valves.
 - b. Provide general exhaust and outside air filter differential pressure monitoring and outside air damper control.
 - c. Unit shall monitor the outside air temperature and humidity after the heat wheel but before the unit cooling coil. The unit shall efficiently control the heat wheel, cooling coil, hot gas bypass coil and natural gas reheat coil to provide unit supply air temperature and humidity setpoint conditions.
 - d. Unit shall also monitor the refrigerant suction pressure.

2.02 UV (ULTRA VIOLET) - C EMITTERS:

- A. Manufacturers: Steril-Aire, Inc., UVDI, or American Ultraviolet. Assembly shall be equal to Steril-Aire Model DE.

- B. Provide UVC emitters at downstream side of coiling coils and above drain pans in air handling units as scheduled to control airborne and surface microbial growth and transfer.
- C. Emitters shall comply with UL Standard 1995 as applicable to usage of UVC emitters in HVAC equipment.
- D. Emitters shall be independently tested under typical HVAC conditions and in accordance with ANSI/ASQCZ1.4. Total output per 25 mm(1") arc length shall not be less than 9 $\mu\text{W}/\text{cm}^2$ at one meter in 2.0 m/s(400 fpm) airstream of 32°C(50°F) air.
- E. UVC emitter and fixture shall consist of housing, power source, reflector, emitter sockets and emitter tube and shall be constructed to withstand HVAC environments.
- F. Housing shall be constructed of 304 or 316 stainless steel with 13 mm(1/2") electrical knockouts on both ends to simplify gang wiring and wiring to power. It shall incorporate components into one integral assembly that maximizes serviceability and radiant flux.
- G. Reflector shall be constructed of heavy gauge, spectral finished aluminum alloy with minimum 85% reflectance at 254 nm UVC energy.
- H. Emitter shall be of high output, hot cathode, T5 (15 mm) diameter, medium bi-pin type, capable of producing 95% of energy at 254 nm in air flow velocity to 5.0 m/s(1000 fpm) at temperature of 1°C to 66°C(35°F - 150°F). UVC emitters shall produce no ozone or other secondary contamination. Useful emitter life shall not be less than 9000 h, with no more than 40% output loss at end of one year of continuous use.
- I. Irradiance: Provide UVC lamps and fixtures in sufficient quantity to irradiate coil surfaces and air stream with no shadows and with minimum UVC irradiance at every point along face of coil at not less than 1225 $\mu\text{W}/\text{cm}^2$ at design cooling conditions with bulb mounted 300 mm(12") from coil face.
- J. UVC Monitoring: Provide NIST traceable UV Radiometer consisting of solid state photodiode UV sensor and externally mounted controller with visual indicators of UVC output and contacts for BAS communication. Controller must have ability to read real-time UVC energy levels by display module with minimum 89 mm(3.5") digit LCD screen/panel. Irradiance range shall be 0-1999 ($\times 10$) $\mu\text{W}/\text{cm}^2$ with resolution of 10 $\mu\text{W}/\text{cm}^2$. Calibration wavelength shall be 254 nm with accuracy $\pm 10\%$.
- K. Electrical:
 - 1. Power source shall be 115 V, with power factor of 0.95 and power conversion of not less than 75%. It shall be designed to maximize photon production, radiance and reliability and suppress RF and line noise in airstreams of 5°C to 56°C(41°F -132°F) and airflows to 5.0 m/s(1000 fpm).
 - 2. Power consumption shall be no more than 13 watts/sf of treated, cross sectional plane.
 - 3. Provide interlock switch on access doors to turn UVC off when access doors are opened. Provide additional manual on/off switch (electrical disconnect) for UVC system service purposes.
- L. Startup and Calibration Service: UV supplier shall provide services to startup, calibrate, monitor, verify output and certify that UVC energy output meets specified requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install all units as indicated on plans and according to unit manufacturer's instructions and all applicable building codes.
- B. General Contractor will set and install roof-mounting curb as integral member of building roof structure.
- C. Install all ductwork, electrical and piping connections to unit as shown on drawings and as required to complete installation.
- D. Provide all wiring between rooftop units, remote panels, time clocks and other temperature control devices.

- E. Manufacturer and/or manufacturer's representative shall calibrate all control devices and adjust unit automatic dampers to insure proper operation of system.
- F. Install space thermostats approximately 4'-0" above floor and as shown on drawings.

3.02 UVC EMITTERS

- A. Install UVC Emitters at outlet of cooling coils and above drain pans in accordance with manufacturer's instructions of installation, placement, wiring and testing.
- B. Provide interlock switch on access door to UVC Emitters to turn Emitters off when access door is opened.

END OF SECTION

**SECTION 23 8126
SPLIT SYSTEM AIR CONDITIONERS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 20 0513 - Motors

1.02 SUBMITTALS

- A. Shop Drawings including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Identification as referenced in the documents
 - 3. Capacities/ratings/efficiencies
 - 4. Materials of construction
 - 5. Filters; size, efficiency
 - 6. Fans, type, drives
 - 7. Motor data (refer to Section 20 0513 - Motors)
 - 8. Power and control wiring diagrams
 - 9. Vibration isolation furnished with units
 - 10. Dimensions and weights
 - 11. Manufacturer's installation instructions
 - 12. All other appropriate data

1.03 DESIGN CRITERIA

- A. Furnish unit complete with all components, accessories, and operating and safety controls to provide the intended performance as specified in this Section, as shown on drawings and/or as scheduled.
- B. Insulation and liners shall meet NFPA-90A Requirements.
- C. Unit shall be UL Listed and carry UL Label.
- D. Coils shall be rated in accordance with AHRA Standard 240 and bear the AHRI certification label.
- E. Fan motor shall not operate into motor service factor in any case.

1.04 OPERATION AND MAINTENANCE DATA

- A. Manuals shall indicate unit model numbers, serial numbers, sizes, type, and indicate name and address of the service company.
- B. Description of maintenance required weekly, monthly, quarterly, semi-annually and annually shall be included along with recommended lubrication type.

1.05 GUARANTEE

- A. Manufacturer and Contractor shall provide warranty for a period of 5 years after acceptance by Owner.
- B. Warranty shall include all cost of parts and labor for any and all work unit manufacturer and/or contractor has to accomplish to repair malfunctioning unit or piece of equipment furnished by unit manufacturer. Warranty shall not cover normal maintenance such as changing of filters or cleaning of coils.
- C. Manufacturer shall provide 7-year warranty for refrigeration compressors.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Manufacturer:
 - 1. Mitsubishi or equal.
 - 2. Equal to manufacturer's model with capacity and operating characteristics as scheduled.
- B. Indoor fan coil unit shall be designed specifically for exposed, ceiling-mounted application.
- C. Outdoor condensing unit shall be designed unit specifically for outdoor, horizontal airflow, wall-hung or rooftop application as shown on drawings.

- D. Unit shall be factory run tested to check operation, fan and blower rotation and control sequence.
- E. System shall include refrigeration compressors, evaporator coil, air cooled condenser assembly, thermal expansion valves, and insulated interconnecting refrigerant piping. Provide all other components required to modulate between heating and cooling modes.

2.02 INDOOR FAN COIL UNIT

- A. Casing:
 - 1. Galvanized steel.
 - 2. Provide duct collars for supply and return duct connections.
 - 3. Provide adjustable support tabs/brackets, minimum 4 per unit for hanger support from structure.
- B. Fan:
 - 1. Statically and dynamically balanced and tested in factory.
 - 2. Bearings shall be permanently lubricated.
 - 3. Unless otherwise indicated, furnish units with 3-speed permanent split capacitor (PSC) or electrically commutated (EC) motors with thermal overload protection with automatic reset.
 - 4. Units shall have multiple fans speeds.
- C. Filters:
 - 1. Filters shall be integral to unit.
 - 2. In addition, furnish one set of temporary throwaway filters to be used during construction and initial start-up periods.
- D. Coil for Indoor Fan Coil Unit:
 - 1. The indoor unit coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 - 2. All tube joints shall be brazed with silver alloy.
 - 3. The coils shall be pressure tested at the factory.
 - 4. A sloped, corrosion resistant condensate pan with drain shall be provided under the coil.
 - 5. Provide a drain pan level switch, designed to connect to the control board, installed on the condensate pan to prevent condensation from overflowing.

2.03 OUTDOOR CONDENSING UNIT

- A. Unit Cabinet:
 - 1. The casing shall be fabricated of galvanized steel and finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection. Assembly hardware shall be stainless steel or cadmium plated for weather resistance.
 - 2. Unit shall include a minimum of two mounting rails or feet that traverse the base, with pre-drilled mounting holes or slots.
- B. Fan:
 - 1. The unit shall be furnished with a direct drive propeller type fan with permanently lubricated bearings.
 - 2. The fan shall be provided with a raised guard to prevent contact with moving parts.
 - 3. The outdoor unit shall have horizontal discharge airflow.
- C. Coil:
 - 1. The outdoor unit coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
 - 2. The coil shall be protected with an integral metal guard.
 - 3. Refrigerant flow from the outdoor unit shall be regulated by means of an electronically controlled expansion valve.
- D. Compressor:
 - 1. The compressor shall be a high performance, hermetic, inverter driven, variable speed, dual rotary type.

2. The outdoor unit shall be equipped with an accumulator.
 3. The compressor shall be equipped with internal thermal overload protection.
 4. Compressor shall be mounted inside of outdoor condensing unit with factory-installed vibration isolation to prevent transmission of vibration to building.
- E. Electrical:
1. Each unit shall include low voltage control transformer.
 2. Motor horsepower and voltages shall be as scheduled.

2.04 UNIT CONTROLS:

- A. Factory-wired packaged controls shall include a power on/off switch, mode selector for automatic mode, fan mode, temperature adjustment, and timer control with clock, and fan speed selector.
- B. The indoor unit shall perform self-diagnostic functions.
- C. The system shall be capable of automatically restarting and operating at the previously selected conditions when the power is restored after power interruption.
- D. Control system shall control the outdoor condensing unit.
- E. Provide manufacturer's accessory thermostat. Thermostat shall be a hard-wired, wall mounted remote controller with a built-in temperature sensor and backlit display to show space temperature in °F.
- F. Unit shall be completely factory wired for 24V controls.
- G. Microprocessor based unit controls shall contain all required algorithms to meet requirements of drawings.
- H. Refrigeration safety controls to include high and low-pressure cutout, compressor overload protections, magnetic contractors and low voltage control transformer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install all units as indicated on plans and according to unit manufacturer's instructions.
- B. Provide all necessary connections to unit as shown on drawings and as required to complete installation.
- C. Support for the indoor fan coil unit shall be from the structure above. Provide vibration isolation in the support rods.
- D. Provide neat and complete duct connections to the fan coil unit and neatly insulate the duct connection to the unit.

END OF SECTION

**SECTION 23 8214
HEATING AND COOLING TERMINAL DEVICES**

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop Drawings for all items in this Section including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Identification as referenced in the documents
 - 3. Capacities/ratings
 - 4. Materials of construction
 - 5. Dimensions and weights
 - 6. Color selection chart where applicable
 - 7. Wiring diagrams
 - 8. All other appropriate data

1.02 REFERENCE STANDARDS AND DESIGN CRITERIA

- A. Electric Heaters: Shall be listed by UL, bear appropriate UL Label, contain the latest devices for protection of installation, and shall be installed in strict accordance with the latest revision of National Electric Code and other applicable State and Local Codes. Provide grounding lugs on all apparatus.

PART 2 - PRODUCTS

2.01 ELECTRIC REHEAT COILS (MOUNTED IN ROOFTOP AHUS)

- A. Manufacturers: Indeeco, Singer, or Brasch
- B. Heaters shall be UL Listed for zero clearance to combustible materials in horizontal air ducts and shall comply with all applicable provisions of the latest National Electric Code.
- C. Heaters shall incorporate suitable combination of automatic reset disc type thermal cutouts for primary protection and manual reset line duty disc type thermal cutouts with external reset for secondary protection.
- D. Heating elements shall be of 80% nickel and 20% chromium alloy wire supported by floating ceramic bushings in reinforced shelves spaced no more than 3-1/2" apart. Heater body shall be of galvanized steel of not less than 18 ga, suitably reinforced for full rigidity.
- E. Heaters shall be rated for KW, voltage, phase and number of heating stages as scheduled.
- F. Heaters shall have the following features:
 - 1. Insulated frames and control box
 - 2. Magnetic contactors
 - 3. Control circuit transformer
 - 4. SCR controller
 - 5. Duct mounted thermostat
 - 6. Fusing to comply with NEC
 - 7. Fused disconnect switch with interlock handle
 - 8. Airflow proving switch
 - 9. Pilot light to indicate that heater supply is "on".
- G. Controls shall be factory wired with terminal connections for power and thermostat.

2.02 DUCT REHEAT COILS (HOT WATER)

- A. Manufacturers: Carrier, Trane, McQuay, RAE, Marlo, Temtrol, or Heatcraft
- B. Reheat coils furnished with air terminal devices will be acceptable, provided coils are meeting requirements specified in this section.
- C. Coils shall be constructed of 0.4 mm(0.016") minimum tube wall, 13 mm(1/2") or 16 mm(5/8") OD copper tubes with aluminum fins suitable for minimum working pressure to 1380 kPa(200 psig) and temperatures to 104°C(220°F).

- D. Coils having steel nipples for connection are not allowed.
- E. Coil fins shall be continuous serpentine or plate fin type.
- F. Coil headers shall be heavy seamless copper with all tubes brazed to header.
- G. Casing shall have G90 galvanized steel end supports and top and bottom channels of rigid construction with allowance for expansion and contraction of finned tube section.
- H. Coil frame shall be suitable for drive slip or flange and gasket connection to ductwork.

2.03 ELECTRIC UNIT HEATERS

- A. Manufacturers: Trane, Berko, Electromode, Modine, or Singer
- B. Heating elements shall be corrosion resistant, installed to prevent noise of expansion and contraction. Units shall be designed for even distribution of air across heating element.
- C. Units shall be furnished with necessary over-heat protection, reset devices, contactors, transformers and control as required for complete operation. Provide factory-installed, adjustable thermostatic control for operation of fan and heater.
- D. Provide each unit with a disconnect interlocked to the control enclosure compartment.
- E. Provide units with fan switches to maintain fan operation until all residual heat in elements has been dissipated.
- F. Fans shall be statically and dynamically balanced. Fans and motors shall be mounted for vibration free operation.
- G. Cabinets and casings shall be minimum 20 ga galvanized or stainless steel for corrosion resistance.
- H. Provide corrosion resistant, protective grilles or louvers on inlet and outlet openings.
- I. Fan motors shall be totally enclosed, permanently lubricated and shall be provided with corrosion resistant windings. Motors shall be factory wired to a NEMA 3, 3X, 4, or 4X enclosure. The entire assembly shall be UL listed.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install units as indicated on drawings, and according to manufacturer's installation instructions.

3.02 DUCT REHEAT COILS

- A. Comb out fins when bent or crushed before enclosing coils in ductwork. Clean dust and debris from each coil to ensure its cleanliness.
- B. Seal or gasket coil connection to ductwork to meet maximum allowable leakage rate specified in Section 23 3114 - Ductwork, Part 3.
- C. Protect units during construction against entry of foreign matter and construction dirt.
- D. Unless otherwise specified, connect piping to coils with multiple rows for counter-flow arrangement. same side.
- E. Provide inlet and outlet transitions per details.
- F. Provide coil access door on the inlet and outlet of each reheat coil for cleaning and inspection. Doors are to be insulated, gasketed and have turn latches. Screwed plate doors are not acceptable.

END OF SECTION

SECTION 26 0000
GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Intent of drawings and Specifications is to obtain complete systems tested, adjusted, and ready for operation.
- B. Except as otherwise defined in greater detail, the terms "provide", "furnish" and "install" as used in Division 26 Contract Documents shall have the following meanings:
 - 1. "Provide" or "provided" shall mean "furnish and install".
 - 2. "Furnish" or "furnished" does not include installation.
 - 3. "Install" or "installed" does not include furnishing.
- C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.
- D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.
- E. Included in this Contract are electrical connections to equipment provided by others. Refer to Architectural, Mechanical, Plumbing, and final shop drawings for equipment being furnished under other sections for exact locations of electrical outlets and various connections required.
- F. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for dimensions.
- G. Where architectural features govern location of work, refer to Architectural Drawings.
- H. Perform work in "neat and workmanlike" manner as defined in ANSI/NECA 1, Standard Practices for Good Workmanship in Electrical Contracting.

1.02 RELATED WORK

- A. Utility Services:
 - 1. Determine utility connection requirements and include in Base Bid all costs to Owner for utility service.
 - 2. Include costs for temporary service, temporary routing of service or other requirements of a temporary nature associated with utility service.
- B. Temporary Services:
 - 1. Division 01 - Temporary Facilities and Controls.
- C. Continuity of Service:
 - 1. No service shall be interrupted or changed without permission from Architect and Owner. Obtain written permission before work is started.
 - 2. When interruption of services is required, Architect, Owner and other concerned parties shall be notified and shall determine a time.
- D. Concrete Work:
 - 1. Provide cast-in-place concrete as required by Contract Documents unless otherwise noted.
 - 2. Concrete shall comply with Division 03 - Concrete.
 - 3. Provide anchor bolts, metal shapes and templates to be cast in concrete or used to form concrete as required for anchoring and supporting electrical equipment.
- E. Painting:
 - 1. Furnish equipment with factory-applied finish coats or paint equipment per Division 09 – Finishes unless specified otherwise.
 - 2. Furnish equipment with factory applied prime finish unless otherwise specified.
 - 3. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Architect.
 - 4. Furnish one can of touch up paint for each final factory-applied finish coat of product.

5. **[Paints and coatings used on the interior of the building shall comply with VOC limits per Section 01352 LEED requirements.]**
- F. **[Sustainable Architecture and LEED Requirements:**
 1. **Provide services, documentation, and product data required to meet LEED credits involving an electrical component such as:**
 - a. **Credit SS Prerequisite 1 – Construction Activity Pollution Prevention**
 - b. **Credit SS 8 – Light Pollution Reduction**
 - c. **Credit EA Prerequisite 1 – Fundamental Commissioning of the Building Energy Systems**
 - d. **Credit EA Prerequisite 2 – Minimum Energy Performance**
 - e. **Credit EA 1 – Optimize Energy Performance**
 - f. **Credit EA 3 – Enhanced Commissioning**
 - g. **Credit EA 5 – Measurement and Verification**
 - h. **Credit EA 6 – Green Power**
 - i. **Credit ID 1.1 – Low Mercury Lamps**
 - j. **Credit ID 1.2 – Exemplary Green Power**
 - k. **Credit MR 2 – Construction Waste Management**
 - l. **Credit MR 4 – Recycled Content**
 - m. **Credit MR 5 – Regional Materials**
 - n. **Credit EQ 4.1 – Low Emitting Materials, Adhesives & Sealants**
 - o. **Credit EQ 4.2 – Low Emitting Materials, Paints & Coatings**
 - p. **Credit EQ 6.1 – Controllability of Systems, Lighting]**
- G. **[Sustainable Architecture and LEED Requirements:**
 1. **Provide services, documentation, and product data required to meet LEED credits involving an electrical component such as:**
 - a. **Credit LT – Green Vehicles**
 - b. **Prerequisite SS – Construction Activity Pollution Prevention**
 - c. **Credit SS – Light Pollution Reduction**
 - d. **Credit WE – Water Metering**
 - e. **Prerequisite EA – Fundamental Commissioning of the Building Energy Systems**
 - f. **Prerequisite EA – Minimum Energy Performance**
 - g. **Prerequisite EA – Building-Level Energy Metering**
 - h. **Credit EA – Enhanced Commissioning**
 - i. **Credit EA – Optimize Energy Performance**
 - j. **Credit EA – Advanced Energy Metering**
 - k. **Credit EA – Demand Response**
 - l. **Credit EA – Renewable Energy Production**
 - m. **Credit EA – Green Power and Carbon Offsets**
 - n. **Prerequisite MR – Construction and Demolition Waste Management Planning**
 - o. **Credit MR – Building Product Disclosure and Optimization – Environmental Product Declarations**
 - p. **Credit MR – Building Product Disclosure and Optimization – Sourcing of Raw Materials**
 - q. **Credit MR – Building Product Disclosure and Optimization – Material Ingredients**
 - r. **Credit MR – Construction and Demolition Waste Management**
 - s. **Credit MR 4 – Recycled Content**
 - t. **Credit MR 5 – Regional Materials**
 - u. **Credit EQ – Low Emitting Materials**
 - v. **Credit EQ – Construction Indoor Air Quality Management Plan**
 - w. **Credit EQ – Interior Lighting**

- x. **Credit EQ – Daylighting**
 - y. **Credit EQ – Acoustic Performance**
 - z. **Credit ID – Innovation**
- H. **[Sustainable Architecture and LEED Requirements:**
- 1. **Provide services, documentation, and product data required to meet LEED credits involving an electrical component such as:**
 - a. **Credit LT – Green Vehicles**
 - b. **Prerequisite SS – Construction Activity Pollution Prevention**
 - c. **Credit SS – Light Pollution Reduction**
 - d. **Credit WE – Water Metering**
 - e. **Prerequisite EA – Fundamental Commissioning of the Building Energy Systems**
 - f. **Prerequisite EA – Minimum Energy Performance**
 - g. **Prerequisite EA – Building-Level Energy Metering**
 - h. **Credit EA – Enhanced Commissioning**
 - i. **Credit EA – Optimize Energy Performance**
 - j. **Credit EA – Advanced Energy Metering**
 - k. **Credit EA – Demand Response**
 - l. **Credit EA – Renewable Energy Production**
 - m. **Credit EA – Green Power and Carbon Offsets**
 - n. **Prerequisite MR – Construction and Demolition Waste Management Planning**
 - o. **Prerequisite MR – PBT Source Reduction - Mercury**
 - p. **Credit MR – Building Product Disclosure and Optimization – Environmental Product Declarations**
 - q. **Credit MR – Building Product Disclosure and Optimization – Sourcing of Raw Materials**
 - r. **Credit MR – Building Product Disclosure and Optimization – Material Ingredients**
 - s. **Credit MR – PBT Source Reduction - Mercury**
 - t. **Credit MR – PBT Source Reduction – Lead, Cadmium, and Copper**
 - u. **Credit MR – Design for Flexibility**
 - v. **Credit MR – Construction and Demolition Waste Management**
 - w. **Credit MR 4 – Recycled Content**
 - x. **Credit MR 5 – Regional Materials**
 - y. **Credit EQ – Low Emitting Materials**
 - z. **Credit EQ – Construction Indoor Air Quality Management Plan**
 - aa. **Credit EQ – Interior Lighting**
 - bb. **Credit EQ – Daylighting**
 - cc. **Credit EQ – Acoustic Performance**
 - dd. **Credit ID – Innovation]**

1.03 REQUIREMENTS OF REGULATORY AGENCIES

- A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of Contract shall become part of this specification.

1.04 REFERENCE STANDARDS

- A. Agencies or publications referenced herein refer to the following:
 - 1. AEIC Association of Edison Illuminating Companies
 - 2. ANSI American National Standards Institute
 - 3. ASME American Society of Mechanical Engineers
 - 4. ASTM American Society for Testing and Materials
 - 5. BICSI Building Industry Consulting Services International
 - 6. EIA Electronic Industries Association
 - 7. FIPS Federal Information Processing Standards

8. FCC Federal Communications Commission
9. ICEA Insulated Cable Engineers Association
10. IEEE Institute of Electrical & Electronics Engineers
11. IESNA Illuminating Engineering Society of North America
12. NEC National Electrical Code
13. NECA National Electrical Contractors Association
14. NEMA National Electrical Manufacturers Association
15. NESC National Electrical Safety Code
16. NETA National Electrical Testing Association
17. NFPA National Fire Protection Association
18. NIST National Institute of Standards & Technology
19. OSHA Occupational Safety and Health Administration
20. TIA Telecommunications Industries Association
21. UL Underwriters Laboratories, Inc.

B. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.05 LISTING

- A. Install materials bearing UL label or UL listing, unless UL label or listing is not available for that type of material.
- B. Other nationally recognized testing agencies, acceptable to AHJ, are approved.

1.06 ENCLOSURES

- A. Typical NEMA Enclosures and Usage
 1. NEMA 1 - Indoors. Falling dirt.
 2. NEMA 2 - Indoors. Falling dirt. Falling liquids. Light splashing.
 3. NEMA 3 - Outdoors. Sleet, snow, rain. Windblown dust.
 4. NEMA 3X - Same as NEMA 3 plus corrosion resistant.
 5. NEMA 3S - Same as NEMA 3 plus mechanism operable when ice covered.
 6. NEMA 3SX - Same as NEMA 3S plus corrosion resistant.
 7. NEMA 3R - Outdoors. Rain, snow, sleet.
 8. NEMA 3RX - Same as NEMA 3R plus corrosion resistant.
 9. NEMA 4 - Indoors. Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down.
 10. NEMA 4X - Same as NEMA 4 - Indoors plus corrosion resistant.
 11. NEMA 4 - Outdoors. Rain, sleet, snow. Wind blown dust. Hose down.
 12. NEMA 4X - Same as NEMA 4 - Outdoors plus corrosion resistant.
 13. NEMA 5 - Indoors. Falling Dirt. Falling Liquids. Settling dust, lint and fibers.
 14. NEMA 6 - Indoors. Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down. Temporary submersion.
 15. NEMA 6P - Same as NEMA 6 - Indoors plus corrosion resistant. Prolonged submersion.
 16. NEMA 6 - Outdoors. Rain, snow, sleet. Windblown dust. Hose down. Temporary submersion.
 17. NEMA 6P - Same as NEMA 6 - Outdoors plus corrosion resistant. Prolonged Submersion.
 18. NEMA 7 - Indoors. Class I, Division 1 or 2, Groups A, B, C or D. (Flammable gas).
 19. NEMA 9 - Indoors. Class II, Division 1 or 2. Groups E, R, or G. (Combustible dust).
 20. NEMA 12 - Indoors. Falling Dirt. Falling liquids. Flying dust, lint and fibers. Oil or coolant seepage.
 21. NEMA 13 - Same as NEMA 12 plus oil or coolant spraying or splashing.

1.07 SUBMITTALS

- A. Shop Drawings (Product Data):

1. Refer to Division 01 - Submittal Procedures.
 2. Note that for satisfying submittal requirements for Division 26, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, the expression "Shop Drawings" is generally used throughout Specification.
 3. Submit shop drawings for equipment and systems as requested in respective specification sections. Submittals which are not requested may not be reviewed.
 4. Specifically mark general catalog sheets and drawings to indicate specific items submitted and its correlation to specific designation for product in drawings.
 5. Specifically indicate proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
 6. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Clearly mark and note submittal accordingly.
 7. Submit complete record of required components when luminaires, equipment and items specified include accessories, parts and additional items under one designation.
 8. Include wiring diagrams for electrically powered or controlled equipment.
 9. Submit electrical equipment room layouts drawn to scale, including equipment, raceways, accessories and required working clearances. Submit electrical equipment room layouts concurrently with electrical distribution equipment submittals.
 10. Where submittals cover products containing non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
 11. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
 12. Submittals that are not complete, not permanent, or not properly checked by Contractor, will be returned without review.
 13. Bidders shall provide a full compliance review of specifications. Compliance review shall accompany submittals. Compliance review shall include paragraph-by-paragraph review of specifications with the following information "C", "D", "E" marked in the margin of the specification section. Unless a deviation or exception is specifically noted in the compliance review, it is assumed that Bidder is in complete compliance with plans and specifications. Lack of these requirements in the submittal shall result in rejection of submittal. Text shall be provided accompanying compliance review as follows:
 - a. "C" – Comply with no exceptions
 - b. "D" – Comply with deviations. For each of the deviations, provide numbered footnote with reasons for proposed deviation
 - c. "E" – Exceptions; do not comply
- B. Bookmarks:
1. Submitted documents greater than 50 pages in length shall include electronic bookmarks setup to quickly navigate and easily locate submitted information. Each major series of equipment shall have a bookmark.
 2. Hyperlinks can be used to enhance bookmark tools but are not an acceptable substitute for electronic bookmarks. If hyperlinks are used, they should be clearly identifiable as a hyperlink by using a different color text similar to how MS Office identifies hyperlinks.
- C. Certificates and Inspections:
1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.
- D. Operation and Maintenance Manuals:
1. Refer to Division 01 - Operation and Maintenance Data.
 2. Upon completion of work but before final acceptance of system, submit to Architect for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one

copy" is larger than 2" thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.

3. Organize manuals by specification section number and furnish table of contents and tabs for each piece of equipment or system.
 4. Manuals shall include the following:
 - a. Copies of shop drawings
 - b. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment, with component exploded views and part numbers. Where manufacturer's data includes several types or models, designate applicable type or model.
 - c. CD ROM's or flash/thumb drives of O&M data with exploded parts lists where available
 - d. Phone numbers and addresses of local parts suppliers and service companies
 - e. Internet/WEB page addresses where applicable
 - f. Wiring diagrams
 - g. Start up and shut down procedure
 - h. Factory and field test records
 - i. Additional information, diagrams or explanations as designated under respective equipment or systems specification section
 5. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
 6. Furnish O&M manuals and instructions to Owner prior to request for final payment.
 7. Include bookmarks as indicated above.
- E. Record Documents:
1. Refer to General Conditions of Contract and Division 01 - Project Record Documents. Prepare complete set of record drawings in accordance with Division 01.
 2. Use designated set of prints of Contract Documents as prepared by Architect to mark-up for record drawing purposes.

1.08 JOB CONDITIONS

- A. Building Access:
1. Arrange for necessary openings in building to allow for admittance of all apparatus.
- B. Coordination:
1. Equipment provided under other Divisions of these specifications.
 - a. Motors
 - b. Electrically powered equipment
 - c. Electrically controlled equipment
 - d. Starters, where specified
 - e. Variable frequency drives, where specified
 - f. Control devices, where specified
 - g. Temperature Control wiring
 2. Provide the following devices required for control of motors or electrical equipment, unless noted otherwise:
 - a. Starters
 - b. Disconnect devices
 - c. Control devices:
 - 1) Pushbuttons
 - 2) Pilot lights
 - 3) Contacts
 - d. Conduit, boxes and wiring for Power wiring
 - e. Conduit, boxes and wiring for Control wiring, except for control wiring systems as defined in Section 23 0901.

3. Connect and wire equipment complete and ready to operate according to wiring diagrams furnished by various trades.
 4. Wire starters or other similar control devices furnished by others.
 5. This contractor's drawings and/or specifications show number and hp rating of motors furnished by others, together with their actuating devices. Should any change in size, hp rating, voltage, or means of control be made to any motor or other electrical equipment after Contracts are awarded, Contractor responsible for change shall immediately notify this Contractor. Additional costs due to these changes shall be responsibility of Contractor initiating change.
 6. Equipment and wiring shall be selected and installed for conditions in which it will be required to perform. (i.e., general purpose, weatherproof, rain tight, explosion proof, dust tight, or any other special type as required.)
 7. Comply with local utility motor starting requirements and provide starters for motors furnished by others as specified herein or under various trade sections of those specifications.
- C. Cutting and Patching:
1. Refer to General Conditions of the Contract and Division 01 - Cutting and Patching.
 2. Perform cutting and patching required for complete installation of systems, unless otherwise noted. Patch and restore work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.
 3. Provide materials required for patching unless otherwise noted.
 4. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
 5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.
- D. Housekeeping and Cleanup:
1. Refer to Division 01 - Closeout Procedures.
 2. As work progresses or as directed by Architect, periodically remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.09 WARRANTY

- A. Refer to Division 01 for general warranty requirements.
- B. Refer to technical sections for warranty requirement for each system.
 1. Where no warranty requirements are called out, warrant as called out in Division 01 equipment, materials, and workmanship to be free from defect.
- C. Repair, replace, or alter systems or parts of systems found defective at no extra cost to Owner.
- D. In any case, wherein fulfilling requirements of any guarantee, if this contractor disturbs any work guaranteed under another contract, this contractor shall restore such disturbed work to condition satisfactory to Architect and guarantee such restored work to same extent as it was guaranteed under such other contract.
- E. Warranty shall include labor, material, and travel time.

PART 2 - PRODUCTS

2.01 PRODUCT SUBSTITUTIONS

- A. Refer to Division 01 - Product Requirements.

PART 3 - EXECUTION

3.01 GENERAL

- A. Verify elevations and dimensions prior to installation of materials.

- B. Where conduits are shown on plans, they are shown for reference only. Conduit routes shown on plans may not show all required junction boxes, pull boxes, control conduits, or coordination with other trades. Contractor is responsible for coordination of all conduit routes with other trades, and providing junction boxes and pull boxes as required by code.

3.02 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site under provisions of Division 01.
- B. Store and protect products under provisions of Division 01.
- C. Store in clean, dry space.
- D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.
- E. Handle in accordance with manufacturer's written instructions.
- F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.
- G. Provide supplemental heat if required to prevent moisture contamination. Provide temporary circuits as required.

3.03 FLOOR, WALL, ROOF AND CEILING OPENINGS

- A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide sleeves and inserts that are to be built into structure during progress of construction.
- B. Remove temporary sleeves, if used to form openings, prior to installation of permanent materials. Utilize minimum 24 ga galvanized sheet metal for permanent sleeves unless otherwise noted.
- C. Provide Schedule 40 carbon steel pipe with integral water stop for steel sleeves required below grade or to exterior.
- D. Submit to Structural Engineer for review and approval size and location of core-drilled holes prior to execution.
- E. Submit product data and installation details for penetrations of building structure. Include schedule indicating penetrating materials, (steel conduit, PVC conduit, cables, cable tray, etc.), sizes of each, opening sizes and sealant products intended for use.
- F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in **[Section 26 0593 - Electrical Systems Firestopping]** **[Section XX XXX – Firestopping]**.
- G. **[Adhesives and sealants used on the interior of the building shall comply with VOC limits per section 01352 LEED requirements.]**
- H. **[Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls, etc. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Submit drawings for approval prior to preparing openings in structural member.]**
- I. Provide 2" clearance around penetration openings intended for raceways and cables. Where fire resistant penetrations are required, size openings in accordance with written recommendations of firestopping systems manufacturer.
- J. Seal non fire-rated floor penetrations with non-shrink grout equal to Embecco by Master Builders, or urethane caulk, as appropriate.
- K. Seal non-rated wall openings with urethane caulk.
- L. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation, or sealing system by another manufacturer approved as equal by Engineer. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.
- M. Finish and trim penetrations as shown on details and as specified.

- N. Provide chrome or nickel plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor's closets, storage rooms, etc., unless suspended ceilings are specified.

3.04 EQUIPMENT ACCESS

- A. Install raceways, cable tray, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocate raceways or accessories to provide maintenance access at no additional cost to Owner.
- B. Install equipment with sufficient maintenance space for removal, repair or changes to equipment. Provide ready accessibility to equipment and wiring without moving other future or installed equipment.
- C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors for equipment shall provide access for servicing, repairs and/or maintenance.
- D. Provide necessary coordination and information to the Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes and rough-in dimensions.
- E. Provide access doors in walls, chases or inaccessible ceilings for equipment requiring access for servicing, repairs and maintenance, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Provide access doors used in fire-rated construction with UL label. Provide steel, prime-coated access doors in dry locations. Provide stainless steel access doors for use in ceramic tile walls, toilet rooms, locker rooms, and in areas subject to excessive moisture. Provide access doors of sufficient size to allow complete maintenance. Coordinate location of access doors with General Contractor and rough-in equipment accordingly.
- F. Locate electrical outlets and equipment to fit details, panels, decorating or finish at space. Architect reserves right to make minor position changes of outlet locations before work has been installed.
- G. Verify door swings before installing room light switch boxes. Install boxes on latch side of door unless otherwise noted

3.05 EQUIPMENT SUPPORTS

- A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers, etc.
- B. Provide steel shell with plug type concrete anchors for attaching equipment to concrete. Plastic, rawhide or anchors using lead are not allowed.
- C. Do not support equipment or luminaires from metal roof decking.

3.06 SUPPORT PROTECTION

- A. In occupied areas, mechanical and electrical rooms and areas requiring normal maintenance access, guard certain equipment to protect personnel from injury.
- B. Provide minimum 1/2" thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.
- C. Protect threaded rods or bolts at supporting elements as described above. Trim threaded rods or bolts such that they do not extend beyond supporting element.

3.07 ELECTRICAL SYSTEMS IDENTIFICATION

- A. Refer to Section 26 0553 – Electrical Systems Identification.

3.08 ACCEPTANCE TESTING

- A. **[Owner shall engage testing and inspection agency to perform acceptance testing of equipment. Equipment to be tested is noted as "Testing by Owner" in technical specification sections.]**
- B. **[Contractor shall engage testing and inspection agency to perform acceptance tests. Equipment to be tested is noted as "Testing by Testing Agency" in technical specification sections. Perform in accordance with Section 26 0812 – Power Distribution Acceptance Tests and Section 26 0813 – Power Distribution Acceptance Test Tables.]**
- C. **[Contractor shall perform acceptance testing. Equipment to be tested is noted as "Testing by Electrical Contractor" in technical specification sections. Perform in accordance with Section 26 0812 – Power Distribution Acceptance Tests and Section 26 0813 – Power Distribution Acceptance Test Tables or as outlined in technical specification sections.]**
- D. When testing is to be witnessed by Architect/Engineer or Inspector, notify them at least **[10]** **[XXX]** days prior to testing date.
- E. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or materials as necessary and repeat inspection and test until equipment or systems meet test requirements. Make repairs with new materials.
- F. Contractor is responsible for certifying in writing equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria and name and title of person signing test certification documents.
- G. **[Submit test results to engineer of record for approval prior to start-up of equipment.]**
- H. Maintain copies of certified test results, including those for any failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

3.09 START-UP

- A. Systems and equipment shall be started, tested, adjusted, and turned over to Owner ready for operation. This includes "Owner-Furnished, Contractor-Installed" (OFICI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.
- B. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.
- C. Contractor shall provide services of technician/mechanic knowledgeable in start-up and checkout of types of systems and equipment on project.
- D. Provide start-up services by manufacturer's representative where specified or where Contractor does not have qualified personnel.
- E. Coordinate start-up with all trades.

3.010 CLEANING

- A. Clean systems after installation is complete.
- B. Vacuum debris from panelboards, switchboards, motor starter and disconnect switch enclosures, junction boxes and pull boxes two weeks before energization and again prior to completion.
- C. Where louvers are provided in switchgear or transformer enclosures, vacuum louvers free of dust and dirt.
- D. Clean luminaire lenses and lamps at time of installation and clean lens exteriors just prior to final inspection.
- E. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.
- F. **[During construction, maintain indoor air quality per general contractors IAQ plan for LEED credit.]**

3.011 [CONSTRUCTION WASTE MANAGEMENT

- A. **Construction waste management shall be managed in accordance with provisions of Section 01 7400 Cleaning and Waste Management. Documentation shall be submitted to satisfy the requirements of that section.]**

END OF SECTION

**SECTION 26 0516
OWNER-FURNISHED EQUIPMENT**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes electrical connection(s) to Owner-purchased pieces of equipment, which are required in construction.
- B. Owner-furnished equipment requiring work by Contractor is specified in the following Sections:
- C. Contractor shall be responsible for receipt of equipment from Owner, storage after receipt, installation, and electrical connection.
- D. Owner-furnished equipment requiring work by the Contractor is shown on the drawings and schedules.
- E. Owner-furnished, Contractor-installed equipment is labeled OFCI.

1.02 SUBMITTALS

- A. Shop Drawings: Owner-supplied shop drawings of equipment furnished by Owner.
- B. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with NFPA 70 for components and installation.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

1.05 WARRANTY

- A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 (NOT APPLICABLE TO THIS SECTION)

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide labor, materials and electrical connections for Owner-furnished equipment in accordance with contract drawings.
- B. Install and connect Owner-furnished equipment as though it had been purchased by Contractor.
 - 1. This shall include:
 - a. Receiving equipment at jobsite
 - b. Rigging and setting equipment in place
 - c. Making electrical connections
 - d. Starting
 - e. Testing
- C. Coordinate with owner equipment provider and start-up technician as required for a complete and working installation.

- D. Install equipment in accordance with manufacturer's installation instructions.
- E. Maintain equipment until facility is accepted by Owner.
- F. Review Owner-supplied shop drawings of Owner-furnished equipment to ascertain that necessary labor and materials have been provided to install equipment and complete the system it serves.

END OF SECTION

SECTION 26 0519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0529 - Hangers and Supports for Electrical Systems
- B. Section 26 0533 - Raceway and Boxes for Electrical Systems
- C. Section 26 0553 - Electrical Systems Identification

1.02 DESCRIPTION

- A. Section includes conductors and cables rated 600 V and less, connectors, splices, and terminations rated 600 V and less, sleeves and sleeve seals for cables.
- B. Conductor and conduit sizes in these contract documents are based on copper wire, and only copper wire shall be used.

1.03 REFERENCE STANDARDS

- A. ASTM B 1 – Standard Specification for Hand-Drawn Copper Wire.
- B. ASTM B 8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. NEMA WC 70 – Non-Shielded Power Cable 2000 V or less for the Distribution of Electrical Energy (ICEA S-95-658).
- D. NFPA 70 – National Electrical Code.
- E. UL 44 – Thermoset-Insulated Wires and Cables.
- F. UL 83 – Thermoplastic-Insulated Wires and Cables.
- G. UL 486A-486B – Wire Connectors.
- H. UL 486C – Splicing Wire Connectors.
- I. UL 486D – Standard for Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.
- J. UL 486E – Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.
- K. UL 1569 – Standard for Metal-Clad Cables.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.
- C. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
- D. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual locations of components and circuits.
 - 2. Operation and Maintenance Data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

1.05 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with NFPA 70 for components and installation.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.
- B. Wire and cable boxes and reels shall bear the date of manufacture.
 - 1. Date of manufacture shall not precede contract date by more than one year.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.07 WARRANTY

- A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. General Cable Corporation
- B. Cerrowire
- C. Southwire Company
- D. Encore Wire Corporation
- E. Approved equal

2.02 DESCRIPTION

- A. NEMA WC 70; single copper conductor insulated wire; 600 V rated insulation; 90°C maximum operating temperature for dry and wet or damp locations.
 - 1. Thermoplastic-insulated wires and cables: NEMA WC 70, UL 83; Type THHN, THWN, THHW, THWN-2.
 - 2. Thermoset-insulated wires and cables: NEMA WC 70, UL 44; Type XHHW, XHHW-2.
- B. Multi-conductor Cable: NEMA WC 70; for metal-clad cable, Type MC with ground wire.
- C. Metal-clad cable, Type MC; UL 1569:
 - 1. Impervious, corrugated, continuous, seam welded metal sheath.
 - 2. Single grounding conductor.
 - 3. Listed for cable tray use

2.03 REMOTE CONTROL AND SIGNAL CIRCUITS

- A. Class 1
 - 1. Copper conductor, single insulated wire.
 - 2. Insulation type THHN or THHW rated 90°C, 600 V insulation class.
 - 3. Type XHHW for ambient temperature less than 32°F.
 - 4. UL 83 listed, ASTM B 1 for solid conductors; ASTM B 8 for stranded conductors.
- B. Classes 2 and 3
 - 1. Copper conductor, multiple twisted conductors covered with an overall non-metallic jacket unless otherwise noted.
 - 2. Insulation type XLPE, rated 105°C, 300 V insulation class.
 - 3. UL listed for use in space in which circuits will be installed.

2.04 CONNECTORS, SPLICES, AND TERMINALS

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division
 - 5. Tyco Electronics Corp.
- B. Description: UL 486A-486B, UL 486C, UL 486D, UL 486E; factory-fabricated connectors, splices, and terminals of size, ampacity rating, material, type, and class for application and service indicated.

2.05 TERMINATIONS

- A. Compression set, bolted or screw type lug, or direct to bolted or screw type terminal.

2.06 PLASTIC CABLE TIES

- A. Nylon or approved; locking type; metallic ties not permitted.

PART 3 - EXECUTION

3.01 INSTALLATION OF CONDUCTORS AND CABLES

- A. Install conductors in a raceway system, unless otherwise specified or indicated.
- B. Install conductors only after:
 - 1. Building interior is enclosed and weather tight
 - 2. Mechanical work likely to damage conductors has been completed
 - 3. Raceway installation is complete and supported
- C. Pull conductors into raceway at same time.
- D. Neatly train and lace conductors inside boxes, equipment, and panelboards.
- E. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- F. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- G. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- H. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible. Protect exposed cables from damage.
- I. Support cables above accessible ceiling using plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.
- J. Support cables and conductors in vertical raceways per requirements in Section 26 0529 - Hangers and Supports for Electrical Systems.
- K. Identify and color-code conductors and cables according to Section 26 0553 - Electrical Systems Identification.
- L. Wiring at Outlets: Install conductor at each outlet, with minimum 6" of slack.
- M. Limit conduit fill to a maximum of 9 current-carrying conductors.
- N. Install stranded conductors where conductors terminate in crimp type lugs. Do not place bare stranded conductors directly under screws.
- O. Install VFD input wiring, output wiring and control wiring in their own separate conduit systems.
- P. Provide dedicated neutrals for branch circuits unless otherwise noted on drawings.

3.02 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid or stranded for #10 AWG and smaller; stranded for #8 AWG and larger.
- B. Branch Circuits: Copper. Solid or stranded for #10 AWG and smaller; stranded for #8 AWG and larger.
- C. Minimum conductor sizes shall be as follows:
 - 1. #12 AWG – Branch circuits of any kind.
 - 2. #14 AWG – Fire alarm system.
 - 3. #16 AWG – Remote control and signal systems.
- D. Branch wiring length limitations:
 - 1. Where wire sizes are shown on project drawings and do not indicate they have been adjusted for voltage drop based on circuit length, they shall be increased as noted below depending on contractor routing.
 - 2. 208Y/120 V circuits over 75' in length: Increase wire size one size for each 75' of length. Increase conduit size as required.

3. 480Y/277 V circuits over 150' in length: Increase wire size one size for each 150' of length. Increase conduit size as required.

3.03 CONDUCTOR INSULATIONS AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2 or XHHW-2, rated 90°C for wet locations, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, rated 90°C for wet locations, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, rated 90°C for wet locations, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, rated 90°C for wet locations, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, rated 90°C for dry and wet or damp locations, single conductors in raceway.
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, rated 90°C for dry and wet or damp locations, single conductors in raceway.
- G. Motor Circuit Branch Wiring and Associated Control Wiring: Type THHN, rated 90°C for dry and damp locations, single conductors in raceway, stranded.
- H. Motor Circuit Branch Wiring Between Motor and VFD: XHHW-2
 1. Requirements for raceway installation when VFD cable is not used:
 - a. Tighten all raceway fittings and connections per manufacturer's requirements.
 - b. Bond and secure raceways to junction boxes.
 - c. Set screw connectors are not permitted.
 - d. Install equipment grounding conductor to be continuous between supply and load.
 - e. Install fittings to provide proper 360° connection between raceway and enclosure at concentric knockouts.
 - f. Remove paint from any surfaces between bond of enclosure, fittings and raceway.
 - g. Provide grounding bushings at enclosures.
 - h. Re-torque all fittings and terminations prior to building turnover.
- I. Wiring in Light Fixture Channels: Type THHN/THWN-2, rated 90°C for dry and damp locations, single conductors.
- J. Branch Circuits Single Conductors in Raceway: 90°C rated conductors sized at 75°C rating for connection to equipment and devices.
- K. Circuits 100A and less, utilize 60C for ampacity (unless both sides of the circuit are listed for 75C). Circuits 100A and over use 75C for ampacity. If the wire insulation ratings are higher, they may be utilized for de-rating purposes only and wire size shall be increased if the de-rated insulation rating is less than the required load current.
- L. Metal-clad cable, Type MC, use for the following:
 1. Feeders from VFDs to motors
 2. Recessed and semi-recessed lighting fixtures
- M. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.04 REMOTE CONTROL AND SIGNAL CIRCUITS

- A. Sizing – #16 AWG minimum.
- B. Installation:
 1. Install cables in cable tray and cable rings.
 2. Provide protection for exposed cables where subject to damage.
 3. Support cables above accessible ceilings; do not rest on ceiling tiles.
 4. Use suitable cable fittings and connectors.

3.05 CONNECTORS, SPLICES, AND TERMINALS

A. Connectors:

1. Except where equipment is furnished with bolted or screw type lug, use compression set pressure connectors with insulating covers. Use compression tools and die compatible with connectors being installed.
2. Use bolt or compression-set type with application of insulating tape, pre-stretched or heat-shrinkable insulating tubing for splices and taps of #8 AWG conductors and larger. Install with hydraulic compression tool.
3. Use pre-insulated "twist-on" connectors with integral spring for splices and taps of #10 AWG conductors and smaller.
4. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
5. Terminate aluminum conductors with tin-plated, aluminum-bodied compression connectors only.
6. Install suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.

B. Splices:

1. Splice wires and cable only in accessible locations such as within junction boxes.
2. Make splices to carry full capacity of conductors with no perceptible temperature rise.
3. Make below-grade splices in manholes and handholes watertight with pre-stretched or heat-shrinkable insulating tubing, or resin-filled insulator.
4. Use electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half-lapped layers of plastic electrical tape, for joints, taps, and splices of #1 AWG conductors and larger.
5. Plastic snap-on splice insulators are not allowed.
6. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
7. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Terminals:

1. Insulate ends of spare conductors with electrical tape and identify spare circuit number where appropriate.
2. Eye type crimped terminal for removable screw type terminal. Forked torque terminal when screw terminal cannot be removed.
3. Train wires to eliminate fanning of stands, crimp with proper tool and die.
4. Torque screw termination per manufacturer's recommended values.

3.06 CABLE TIES

- #### **A.**
- Neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported.

3.07 FIELD QUALITY CONTROL

- #### **A.**
- Perform electrical acceptance testing on all 600 volt conductors and cables serving switchboards and service entrance equipment.
1. Verify tightness of accessible bolted connections by calibrated torque wrench.
 2. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential to be 1000 volts DC for one minute. Minimum insulation resistance values shall not be less than 50 megohms. Investigate and correct any deviations between adjacent phases and values below minimum.
 3. Perform continuity test to ensure correct cable connection.
- #### **B.**
- Interpret test results in writing and submit to Engineer.

- C. Replace conductors and cables that are found defective, at no expense to Owner.

END OF SECTION

SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0533 – Raceway and Boxes for Electrical Systems
- B. Section 26 0533.13 – Surface Raceway Systems
- C. Section 26 2200 Low-Voltage Transformers
- D. Section 26 2416.13 – Lighting and Appliance Panelboards
- E. Section 26 2416.16 – Distribution Panelboards
- F. Section 26 2726 – Wiring Devices
- G. Section 26 2816 – Enclosed Switches and Circuit Breakers
- H. Section 26 2913 – Enclosed Controllers
- I. Section 26 3213 – Engine Generators
- J. Section 26 4113 - Lightning Protection for Structures
- K. Section 26 4300 – Surge Protective Devices (SPD)
- L. Section 26 5000 – Lighting
- M. Section 27 1000 - Structured Cabling
- N. Section 27 1100 - Communications Equipment Room Fittings
- O. Section 27 1300 - Communications Backbone Cabling
- P. Section 27 1500 - Communications Horizontal Cabling

1.02 DESCRIPTION

- A. Section includes methods and materials for grounding systems and equipment, as required by State Codes, NFPA 70, applicable portions of other NFPA codes, as indicated herein, plus the following special applications:
 - 1. Common ground bonding with lightning protection system.
- B. Maximum resistance to ground shall be less than 25 ohms.
- C. Refer to Grounding Riser Diagram.

1.03 REFERENCE STANDARDS

- A. TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
- B. ASTM B 3 – Specification for Soft or Annealed Copper Wire
- C. ASTM B 8 – Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft
- D. ASTM B 33 – Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes
- E. IEEE C2 – National Electrical Safety Code (ANSI)
- F. IEEE 857 – Standard for Qualifying Permanent Connections Used in Substation Grounding
- G. NETA MTS – Maintenance Testing Specifications
- H. NFPA 70 – National Electrical Code
- I. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance
- J. NFPA 780 – Lightning Protection Systems
- K. UL 96 – Lightning Protection Components
- L. UL 467 – Grounding and Bonding Equipment

1.04 TELECOMMUNICATIONS GROUNDING SYSTEM DEFINITIONS

- A. Grounding Equalizer (GE): Conductor that interconnects elements of telecommunications grounding infrastructure.
- B. Telecommunications Bonding Backbone (TBB): Conductor that interconnects telecommunications main grounding busbar (TMGB) to telecommunications grounding busbar (TGB).

- C. Telecommunications Bonding Conductor: Conductor that interconnects telecommunications bonding infrastructure to building's service equipment (power) ground.
- D. Telecommunications Grounding Busbar (TGB): Interface to building telecommunications grounding system, common point of connection for telecommunications system and equipment to ground, and located in telecommunications room or equipment room.
- E. Telecommunications Main Grounding Busbar (TMGB): Busbar placed in convenient and accessible location and bonded by means of bonding conductor for telecommunications to building service equipment (power) ground.

1.05 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals:
 - 1. Plans showing dimensioned as-built locations of grounding features, including the following:
 - a. Test wells
 - b. Ground rods
 - c. Ground rings
 - d. Grounding arrangements and connections for separately derived systems
 - e. Grounding for sensitive electronic equipment
- C. Field Quality-Control Test Reports:
 - 1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
 - 2. Test reports of resistance to earth. Each test report shall include:
 - a. Date of test, soil moisture content, and soil temperature
 - b. Test operator
 - c. Instrument or other test equipment used
 - d. Electrode designation or location
 - e. Ground impedance in ohms
 - f. Assumptions made - if required
- D. Closeout Submittals:
 - 1. Operation and Maintenance Manuals: Include the following:
 - a. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems based on NFPA 70B.
 - 1) Instructions to perform tests to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
 - 2) Include recommended testing intervals.

1.06 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70.
 - 2. Comply with UL 467 for grounding and bonding materials and equipment.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store products in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.08 WARRANTY

- A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

- B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction, insulation color: green.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of #17 AWG conductor, 1/4" in diameter.
 - 5. Bonding Conductor: #4 AWG or #6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8" wide and 1/16" thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8" wide and 1/16" thick.
- C. Grounding Bus: Horizontal rectangular bars of annealed copper, 1/4" by 2" in cross section; with insulators.

2.02 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 Connectors for Conductors and Pipes: Electro-tin plated copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Compression Connectors: Irreversible type.

2.03 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4" in diameter by 10 ft in length.

2.04 TELECOMMUNICATIONS BUSBARS

- A. Material: Copper
 - 1. 1/4" thick
- B. Pre-drilled
 - 1. 3/8" diameter
 - 2. Hole spacing per ANSI Joint Standard TIA-607-B
 - 3. Hole pattern shall accommodate two-hole lugs
- C. Insulators and stand-off brackets shall electrically isolate busbar from wall or other mounting surface.
- D. Provide busbars listed by nationally recognized testing laboratory.
- E. Size:
 - 1. Telecommunications Main Ground Busbar (TMGB) – 20" x 4" (minimum)
 - 2. Telecommunications Grounding Busbar (TGB) – 12" x 2" (minimum)

2.05 TELECOMMUNICATIONS GROUNDING CONDUCTORS

- A. Material: Stranded copper
- B. Provide insulated bonding conductors.

1. Green Jacket or Black Jacket marked with Green Tape or Green adhesive labels per NEC Guidelines.
- C. Size:
 1. Bonding Conductor for Telecommunications (BCT; TMGB to Grounding Electrode): as indicated on drawings
 2. Telecommunications Bonding Backbone (TBB; TMGB to TGB): as indicated on drawings

2.06 TELECOMMUNICATIONS GROUNDING CONNECTIONS

- A. Mechanical Connectors:
 1. Connector Body:
 - a. High-strength, high-conductivity cast copper alloy
 - b. 2-bolt type
 2. Bolts, nuts, washers, and lock-washers: 300 series stainless steel
 - a. Supplied as part of connector body
 - b. Split-bolt connector types are not allowed.
 3. Connector:
 - a. Meet or exceed UL 467
 - b. Clearly marked with catalog number, conductor size, and manufacturer
- B. Compression Connectors:
 1. Connector Body: Pure wrought copper.
 2. Conductivity shall be no less than 99% by IACS Standards.
 3. Connector:
 - a. Meet or exceed performance requirements of IEEE 837, latest revision.
 - b. Filled with an oxide-inhibiting compound.
 - c. Clearly marked with manufacturer, catalog number, conductor size, and required compression tool settings.
 4. Connection shall be irreversible.

PART 3 - EXECUTION

3.01 APPLICATIONS

- A. Conductors: Install solid conductor for #8 AWG and smaller, and stranded conductors for #6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install copper or bare-tinned copper conductor. No. #2/0 AWG minimum.
 1. Bury at least 24" below grade.
- C. Grounding Bus: Install in electrical and communications rooms.
 1. Install bus on insulated spacers 1", minimum, from wall; 6" above finished floor.
 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and 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

3.02 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with feeders and branch circuits.
 1. Install a single insulated equipment ground conductor for each branch circuit conduit originating from panelboards.

- 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
- C. Air-Duct Equipment Circuits: Install a separate 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. Ground ductwork of fans serving flammable liquid storage rooms or fume hoods. Install continuous ground around any flexible connections in this ductwork system. Bond lower end of exhaust ducts, vent stacks, etc., which pass through roof.
- D. Metallic Cable Tray: #6 AWG to every tray section, or submit UL Listed tray connectors suitable for electrical continuity
- E. Metallic Sleeves: Minimum #6 AWG
- F. Water Heater and Heat-Tracing 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.
- G. Duplex receptacles and light switches of any amperage: Install separate jumper between grounding terminal on device and metallic box.
- H. Size of equipment grounding conductors for branch circuits: As indicated in NEC-70, except minimum size shall be #12 AWG.
- I. Size of branch panel feeder originating at main service equipment: As indicated in NEC-70, except in no instance smaller than #8 AWG.
- J. Signal and Communication Equipment: For alarm and other communication equipment (see Telecommunications Grounding System Installation section below for voice and data systems), install #4 AWG minimum grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor as indicated on drawings.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- K. Install grounding conductor from each standby-emergency generator to grounding electrode system. Provide flexible jumper between base and isolated generator.
- L. Install equipment grounding conductor from secondary side of each transformer to grounding electrode system as required for separately derived system.
- M. Install grounding for service entrance equipment room consisting of ground bus, ground conductors, and grounding rods.
 - 1. Ground bus shall be horizontal copper bar as indicated on drawings. Bolt to wall with 1" stand-offs at each bus support.
 - 2. Install ground bus per details on drawings.
- N. Install grounding conductor to luminaires hanging from conduit swivel hangers.
- O. 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 to pole base. Grounding Conductor: Same size as phase conductors, but not smaller than #10 AWG.
 - 1. Install at each pole or standard a concealed driven 3/4" x 10'-0" ground rod, ground clamp and No. 3 stranded copper conductor concealed and attached to pole and base.

3.03 SEQUENCING, SCHEDULING

- A. Permanently attach service grounds before permanent building service is energized.
- B. Permanently attach equipment grounds prior to energizing equipment.

3.04 INSTALLATION

- A. Contractor shall take photographs of all underground grounding and bonding connections prior to covering. Furthermore, contractor shall coordinate with the Authority Having Jurisdiction to confirm approval of installation prior to covering.
- B. Connections: Exposed and visible for inspection at all times. Do not install insulation over ground connections.
- C. Identify all grounding conductors by system and room number of termination at building grounding electrode point.
- 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. 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.
- F. Ground Rods: Drive rods until tops are 2" 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 3 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.
- G. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes shall be at least 12" deep, with cover.
 - 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.
- H. 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 for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- I. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, 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. Water pipe, by itself, is not an adequate grounding electrode and must be supplemented by another electrode system. Bond system together.
 - 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.
 - a. Confirm application with local gas and electric utility ordinances and notify the engineer if restrictions do not allow bonding as required by the project documents.
- J. Grounding Electrode Conductor installed in metal conduit or sleeves, shall be bonded at each end using grounding hubs. The bonding conductor shall be the same size as the grounding electrode conductor. Conduits terminated to grounding enclosures, shall be secured to enclosure using grounding locknuts.
- K. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned copper bonding jumper to bond across flexible duct connections to achieve continuity.
- L. Make grounding connections on surface that has been cleaned of paint, dirt, oil, etc., so that connections are bare metal to bare metal contact.
- M. Make grounding connections tight with UL listed grounding devices, fittings, bushings, etc.
- N. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod, extending around the perimeter of building.
 1. Install copper or tinned copper conductor not less than #2/0 AWG for ground ring.
 2. Bury ground ring not less than 24" from building foundation and 30" below grade.
- O. Equipment Grounding Conductor: Terminate in panelboard at green wire ground bus.
- P. Multiple Conductors on Single Lug: Not permitted. Terminate each grounding conductor on its own terminal lug.
- Q. Flexible Metallic Conduit, Non-Metallic Rigid Conduit, or Liquid Tight Flexible Conduit: Install green wire grounding conductor with phase conductors in conduit.

3.05 TELECOMMUNICATIONS BONDING AND GROUNDING SYSTEM INSTALLATION

- A. Provide required elements and miscellaneous hardware necessary to establish Telecommunication Bonding and Grounding infrastructure as specified.
- B. Install products in accordance with manufacturer's instructions. Install Compression Connectors with compression, tool-and-die system, as recommended by manufacturer of connectors.
- C. Telecommunications Bonding Conductor, Telecommunications Bonding Backbone (TBB), and Grounding Equalizer (GE): Compression or Exothermic type connections.
- D. Locate TGBs and TMGB per drawings.
- E. Telecommunications Bonding Backbone (TBB) shall be continuous and not interrupted by Telecommunications Grounding Busbars (TGB).
 1. TGBs shall be bonded to TBB via tap off of TBB. Exception: "last" TGB on TBB (e.g., furthest from TMGB).
 2. Grounding Equalizer(s) (GE) shall connect to TGBs to be interconnected.
- F. Insulate busbars from their support.
- G. Coordinate with Sections 27 1000, 27 1100, 27 1300 and 27 1500.

3.06 FIELD QUALITY CONTROL

- A. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 1. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal and at ground test wells. Make tests at ground rods before any conductors are connected.
- B. Inspect completed system by commissioning authority, prior to backfilling.

END OF SECTION

SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0533 – Raceway and Boxes for Electrical Systems
- B. Section 26 2200 – Low-Voltage Transformers
- C. Section 26 2416.13 – Lighting and Appliance Panelboards
- D. Section 26 2416.16 – Distribution Panelboards
- E. Section 26 2816 – Enclosed Switches and Circuit Breakers
- F. Section 26 2913 – Enclosed Controllers
- G. Section 26 3213 – Engine Generators
- H. Section 26 3623 – Automatic Transfer Switches
- I. Section 26 5000 – Lighting

1.02 DESCRIPTION

- A. Section includes the following:
 - 1. Manufactured hangers and supports for individual raceways and cables, slotted channel and angle systems for multiple conduit runs, and most electrical equipment that is not floor mounted.
 - 2. Construction requirements for concrete housekeeping pads for floor-mounted electrical equipment.

1.03 REFERENCE STANDARDS

- A. AWS D1.1/D1.1M – Structural Welding Code-Steel.
- B. ASTM A 36/A 36M – Carbon Structural Steel.
- C. ASTM F3125/F3125M – Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.
- D. ASTM A 780 – Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- E. MSS SP-58 – Pipe Hangers and Supports - Materials, Design and Manufacture.
- F. MSS SP-69 – Pipe Hangers and Supports - Selection and Application.
- G. MFMA-4 – Metal Framing Standards Publication.
- H. NECA 1 – Standard Practices for Good Workmanship in Electrical Construction.
- I. NECA 101 – Standard for Installing Steel Conduits (Rigid, IMC, EMT).
- J. NFPA 70 – National Electrical Code.
- K. SSPC-PA 1 – Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel.
- L. ETL PVC-001 – PVC Coated Conduit

1.04 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
 - 3. Raceway and cable supports.
 - 4. Support for conductors in vertical raceway.
 - 5. Structural steel for fabricated supports and restraints.
 - 6. Mounting, anchoring, and attachment components:
 - a. Powder-actuated fasteners.
 - b. Mechanical-expansion anchors.
 - c. Concrete inserts.

- d. Clamps for attachment to structural steel.
 - e. Through bolts.
 - f. Toggle bolts.
 - g. Hanger rods.
- B. Shop Drawings: Include concrete anchors application, size, and placement. Include concrete inserts application, size, loading, and placement. Show fabrications and installation details and include calculations for the following:
- 1. Trapeze hangers. Include product data for components.
 - 2. Steel slotted channel systems. Include product data for components.
 - 3. Nonmetallic slotted channel systems. Include product data for components.
 - 4. Fabricated metal equipment support assemblies.
- C. Drawings showing specific locations of any suspended loads which exceed 100 lbs within joist chord panel, to be attached to open web steel joist structural members. Include weight supported by such attachments. (Panel is length of chord between two adjacent diagonal web members at points of connection to chord.)
- D. Welding certificates and drawings showing specific locations of any weld attachments to structure including weight supported by such attachments.
- 1. Any proposed weld attachments to building structure shall be reviewed by Structural Engineer prior to execution of work. This review may result in use of other welding codes or standards, which may apply to "structural work". Execution of this work may be assigned to General Trades responsible for building structural steel. Cost of this work, however, will remain the responsibility of this Contractor.
- E. Schedule of hangers and support devices with support spacing.

1.05 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel."
- B. Comply with NFPA 70.
- C. Certification:
 - 1. Installer of PVC-coated hangers and supports shall be certified by a PVC conduit manufacturer.

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of 5 times the applied force.
- B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Finishes
 - a. Metallic Coatings:
 - 1) Factory standard primed, galvanized or electroplated finish and applied according to MFMA-4, for indoor applications.
 - 2) Hot-dip galvanized after fabrication and applied according to MFMA-4, for outdoor applications.
 - b. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4, for corrosive environments.
 - c. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 2. Channel Dimensions: Selected for applicable load criteria.
 - 3. Manufacturers:

- a. Allied Support Systems; Power-Strut Unit.
 - b. Cooper B-Line, Inc.; A division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corporation.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - h. National Pipe Hanger Corporation.
 - i. Michigan Hanger Co., Inc.; O-Strut Division.
 - j. Approved equal.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Raceway and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. PVC Raceway Support Devices: ANSI C80.1, UL6, ETL PVC-001.
- F. Support for 600V and under Conductors in Vertical Raceway: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
1. Manufacturers:
 - a. O-Z/Gedney
 - b. Approved equal
- G. Support for Conductors 601V and greater in Vertical Raceway: Heavy duty strain relief grip consisting of solder protector, galvanized steel mesh, endless multi-weave style.
1. Manufacturers:
 - a. Hubbell-Kellems
 - b. Approved equal
- H. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- I. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Concrete Anchors
 - a. Anchors shall be selected, sized, and detailed by Contractor's structural engineer registered in project's jurisdiction, based on project conditions and in accordance with project building code. Calculations and drawings shall be submitted.
 - b. Anchors shall meet ICC Acceptance Criteria, and ICC-ES Evaluation Reports (ESRs) shall specifically list the current applicable codes.
 - c. Anchors installed in hardened concrete for purpose of transmitting structural loads from one connected element to another, or for safety related elements such as sprinkler pipes, heavy suspended pipes, and barrier rails shall have ICC-ES report demonstrating anchors have met requirements of AC 193 for mechanical anchors in concrete elements.
 - d. Post-installed expansion anchors and undercut anchors installed in hardened concrete shall be qualified for strength design and tested according to ACI 355.2. Designs shall be per the requirements of ACI 318, Appendix D.
 - e. Anchors for seismic load application shall be approved by ICC-ES Evaluation Reports to resist seismic loads and selected to meet project seismic design requirements. Refer to Section 20 0549 – Seismic Anchorage and Restraints and Structural drawings.
 - f. Anchors shall be zinc plated in accordance with ASTM B633.

- g. Select anchors with load ratings based on cracked concrete conditions.
- h. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 1) Manufacturers:
 - a) Hilti Inc.
 - b) ITW Ramset/Red Head; A division of Illinois Tool Works, Inc.
 - c) MKT Fastening, LLC.
 - d) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit
 - e) Approved equal
 - i. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - 1) Manufacturers:
 - a) Cooper B-Line, Inc.; A division of Cooper Industries
 - b) Empire Tool and Manufacturing Co., Inc.
 - c) Hilti Inc.
 - d) ITW Ramset/Red Head; A division of Illinois Tool Works, Inc.
 - e) MKT Fastening, LLC.
 - f) Approved equal
 - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - J. Beam Clamps: C-clamps are allowed 3/8" or smaller and only for static loading such conduits. Provide locknut for hanging rod at clamp. C-clamps are not allowed for open web steel joist applications nor seismic applications.
 - K. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - L. Toggle Bolts: All-steel springhead type.
 - M. Hanger Rods:
 - 1. MSS SP-58; threaded steel, with adjusting and lock nuts; electroplated zinc finish.
 - 2. MSS SP-58; nonmetallic, with adjusting and lock nuts.

2.02 FABRICATED METAL FRAMING EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates; not be lighter than 12 ga.
- C. Finish: Epoxy paint
- D. Manufacturers: Same as in paragraph 2.1.B.3 above.

2.03 CONTINUOUS INSERT CHANNELS

- A. Length and support capabilities to be suitable for application.
- B. Brackets, inserts and accessories suitable for channel insert selected.
- C. Manufacturers:
 - 1. Unistrut; Tyco International, Ltd.
 - 2. Cooper B-Line, Inc.; A division of Cooper Industries
 - 3. Michigan Hanger Co., O-Strut Division
 - 4. Anvil International, Inc.
 - 5. Approved equal

PART 3 - EXECUTION

3.01 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70.
 - 1. Size steel hanger rods for individual hangers and trapeze supports as indicated in the following schedule. Total weight of equipment shall not exceed limits indicated.

<u>Maximum Loads (lbs)</u>	<u>Rod Diameter (")</u>	<u>Maximum Pipe Size With Single Rod</u>
730	3/8	2"
1130	1/2	3"
1818	5/8	5"

- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25% in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with 2-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 3/4" and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- E. Install PVC-coated hangers and supports in areas with corrosive atmosphere.

3.02 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements, except as specified in paragraphs below.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor application size and placement shall be reviewed and approved by Structural Engineer prior to installation. Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4" thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4" thick.
 - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- F. Do not support raceway by other raceway.

- G. Do not support equipment or raceway from metal roof decking or floor decking.
- H. Do not impose weight of electrical equipment, raceways, or lighting fixtures on support provided for other trades or systems.
- I. Top or bottom chords of open web steel joists may be used to support loads provided total load within panel does not exceed 100 lbs and load is placed concentric to joist (panel is length of chord between two adjacent diagonal web members at point of connection to chord).
 - 1. C-clamps are not permitted for use in open web steel joist applications.
- J. Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.
- K. Use conduit-mounting pedestals for piping on roof. Install bottom of pedestal flat on roof deck and insulate exterior of pedestal, flashing and counter flashing.
- L. Minimize use of concrete anchors and inserts after concrete pour.
- M. Punching, drilling, welding of building structural steel or welding attachment to building structural steel is not allowed, unless approved by structural engineer.
- N. Use tools approved for use with PVC-coated conduits and fittings.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 CONCRETE HOUSEKEEPING PADS

- A. Construct concrete housekeeping pads for all floor-mounted electrical equipment.
- B. Dimensions: 3.5" high and not less than 2" larger in both directions than supported equipment, so anchors will be a minimum of 10 bolt diameters from edge of the base.
- C. Use 3000 psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Anchor equipment to concrete housekeeping pad.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- E. Coordinate with Architect installation of housekeeping pads on roof.

3.05 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 Sections "Interior Painting" and "Exterior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 26 0533
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 0526 – Grounding and Bonding for Electrical Systems
- C. Section 26 0529 – Hangers and Supports for Electrical Systems
- D. Section 26 0553 – Electrical Systems Identification
- E. Section 26 2726 – Wiring Devices
- F. Section 27 0553 – Communications Systems Identification
- G. Section 27 1100 – Communications Equipment Room Fittings
- H. Section 27 1300 – Communications Backbone Cabling
- I. Section 27 1500 – Communications Horizontal Cabling

1.02 DESCRIPTION

- A. Section includes raceways, fittings, wireways, outlet boxes, pull and junction boxes, floor boxes, and raceway seals.

1.03 REFERENCE STANDARDS

- A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting
- B. ANSI C80-1 – Rigid Steel Conduit-Zinc Coated (GRS)
- C. ANSI C80-3 – Electrical Metallic Tubing-Zinc Coated (EMT)
- D. ANSI C80-5 – Aluminum Rigid Conduit-Zinc Coated (ARC)
- E. ANSI C80-6 – Intermediate Metal Conduit-Zinc Coated (IMC)
- F. ASTM A 53/A 53M – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
- G. BICSI TDMM – Telecommunications Distribution Methods Manual, Latest Edition
- H. ETL PVC-001 – PVC-Coated Conduit
- I. NEMA 250 – Enclosures for Electrical Equipment (1000 V Maximum)
- J. NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
- K. NEMA OS 1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
- L. NEMA OS 2 – Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports
- M. NEMA RN 1 – Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
- N. NEMA TC 2 – Electrical Polyvinyl Chloride (PVC) Conduit
- O. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing
- P. NFPA 70 – National Electrical Code
- Q. TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces
- R. UL 1 – Flexible Metal Conduit
- S. UL 6 – Electrical Rigid Metallic Conduit-Steel
- T. UL 6A – Electrical Rigid Metallic Conduit-Aluminum and Stainless Steel
- U. UL 360 – Liquid-Tight Flexible Steel Conduit
- V. UL 514A – Metallic Outlet Boxes
- W. UL 514B – Conduit, Tubing, and Cable Fittings
- X. UL 514C – Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
- Y. UL 651 – Schedule 40 and 80 Rigid PVC Conduit and Fittings
- Z. UL 797 – Electrical Metallic Tubing-Steel
- AA. UL 870 – Wireways, Auxiliary Gutters, and Associated Fittings
- BB. UL 1242 – Electrical Intermediate Metal Conduit-Steel
- CC. UL 1660 – Liquid-Tight Flexible Nonmetallic Conduit

1.04 SUBMITTALS

- A. Product Data:
 - 1. Raceways
 - 2. Fittings
 - 3. Wireways
 - 4. Outlet boxes
 - 5. Pull and junction boxes
 - 6. Floor boxes
 - 7. Raceway seals
- B. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.
- C. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual routing of raceways larger than 2".
 - b. Record actual location and mounting heights of wireways, wall ducts, indoor service poles, floor boxes, tap boxes, outlet, pull and junction boxes.
 - 2. Operation and Maintenance Data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
 - b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.05 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with NFPA 70.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.
- B. Certification:
 - 1. Installer of PVC-coated conduits and fitting shall be certified by a PVC conduit manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.
- B. Protect PVC conduit from sunlight.
- C. Comply with manufacturer's written instructions.

1.07 WARRANTY

- A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 RIGID METAL CONDUIT (RMC)

- A. Rigid Steel Conduit (RSC): ANSI C80.1, UL 6; heavy wall galvanized steel
- B. Intermediate Metal Conduit (IMC): ANSI C80.6, UL 1242; thinner wall, galvanized steel
- C. Rigid Aluminum Conduit (RAC): ANSI C80.5; heavy wall aluminum

- D. PVC coated rigid steel conduit: NEMA RN 1, ANSI C80.1, UL 6, ETL PVC-001; plastic cap protector caps
- E. Fittings (couplings, connectors and bushings): NEMA FB 1, UL 514B; steel (concrete-tight where applicable); threaded; connectors with double locknuts and steel insulating bushings, thermoplastic insulating bushings for conduits 2" and smaller.
- F. Fittings (conduit bodies): NEMA FB 1, UL 514B; aluminum die-cast; cover: stamped steel, with stainless steel screws and neoprene gaskets; PVC coated to match conduit.
- G. Fittings Manufacturers: Cooper Crouse-Hinds; Carlon Electric Products/Prime Conduit Inc.; O-Z/Gedney; Appleton; Hubbell; Approved equal

2.02 ELECTRICAL METALLIC TUBING (EMT)

- A. ANSI C80.3, UL 797; galvanized steel tubing
- B. Fittings (couplings and connectors): NEMA FB I, UL 514B; steel, gland compression type connectors with double locknuts and insulated throat. Indentor, drive-on, zinc die-cast or pressure cast not permitted.
- C. Fittings (conduit bodies): NEMA FB 1, UL 514B: aluminum die-cast; cover: stamped steel, with stainless steel screws and neoprene gaskets.
- D. Fittings Manufacturers: Same as manufacturers listed in 2.1.G.

2.03 FLEXIBLE METAL CONDUIT (FMC)

- A. UL 1; interlocked steel
- B. Fittings: NEMA FB I, UL 514B; steel, die-cast fittings not permitted

2.04 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. UL 360; interlocked steel with PVC jacket
- B. Fittings: NEMA FB 1, UL 514B; steel

2.05 RIGID NONMETALLIC CONDUIT (RNC)

- A. NEMA TC 2, UL 651; Schedule 40 PVC
- B. Fittings: NEMA TC 3, UL 651

2.06 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

- A. UL 1660; flexible conduit with a plastic sheath
- B. Fittings: UL 514B

2.07 STAINLESS STEEL CONDUIT

- A. UL 6A
- B. Type 304
- C. Fittings: Threaded

2.08 METAL WIREWAYS

- A. NEMA 250, UL 870; sheet metal troughs with hinged or removable cover, Type 1, unless otherwise indicated.
- B. Size: Minimum 4" x 4", length as indicated on drawings.
- C. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mated with wireways as required for complete system.
- D. Wireways Covers: Screw-cover type
- E. Knockouts: Manufacturer's standard
- F. Finish: Manufacturer's standard enamel finish
- G. Manufacturers: Hoffman; Square D Co.; Approved equal

2.09 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, UL 514A; galvanized steel with stamped knockouts.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; 1/2" male fixture studs, where required.

2. Concrete Ceiling Boxes: Concrete type
- B. Cast-Metal Outlet Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover and threaded hubs
 1. For applications requiring more than 2 gang boxes, provide stainless steel custom fabricated welded boxes with threaded hubs and coverplate. For applications including terminations and splicing of power conductors, a standard UL Listed box shall be used inside of the custom fabricated box.
- C. Nonmetallic Outlet Boxes: NEMA OS 2
- D. Gangable type boxes are not allowed.
- E. Manufacturers: O-Z/Gedney; Raco; Cooper Crouse-Hinds; Approved equal

2.010 OUTLET BOXES FOR COMMUNICATIONS

- A. Minimum outlet box size: 4-11/16" square by 2-1/8" deep minimum, with single-gang trim ring, unless otherwise noted on drawings.
 1. Total depth of the assembly including the trim ring shall not be less than 2-1/2".

2.011 PULL AND JUNCTION BOXES

- A. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1; galvanized steel
- B. Cast-Metal, Pull, and Junction Boxes: NEMA FB 1; cast aluminum with ground flange, gasketed cover and stainless steel cover screws
- C. Minimum size: 4" square by 2-1/8" deep for use with 1" conduit and smaller; 4-11/16" square by 2-1/8" deep for use with 1-1/4" conduit and larger
- D. Sheet Metal Boxes Larger Than 12" in any direction: Hinged cover or a chain installed between box and cover
- E. Field-fabricated boxes not allowed without prior approval of local authority having jurisdiction.
- F. Manufacturers: O-Z/Gedney; Raco; Cooper Crouse-Hinds; Approved equal

2.012 PULL AND JUNCTION BOXES FOR COMMUNICATIONS

- A. Size: Per TIA-569-B, unless otherwise noted on drawings.
- B. Minimum pull box size: 4-11/16" square by 2-1/8" deep, where pull box is used with raceway(s) smaller than 1-1/4" trade size, unless otherwise noted on drawings.
- C. Minimum pull box size, where pull box is used with raceway(s) 1-1/4" trade size or larger:
 1. For straight pull through: Length of at least 8 times trade-size diameter of largest raceway.
 2. For angle and U pulls:
 - a. Have distance between each raceway entry inside box and opposite wall of box of at least 6 times trade-size diameter of largest raceway, this distance being increased by sum of trade-size diameters of other raceways on same wall of box; and
 - b. Have distance between nearest edges of each raceway entry enclosing same conductor of at least:
 - 1) Six times trade-size diameter of raceway; or
 - 2) Six times trade-size diameter of larger raceway if raceways are of different sizes.
 - c. For raceway entering wall of pull box opposite to removable cover, have distance from wall to cover of not less than trade-size diameter of largest raceway plus 6 times diameter of largest conductor.

2.013 POKE-THROUGH FITTINGS

- A. Poke-Through Fittings: Assembly comprising service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.
 1. Fire Rating: 3h
 2. Service Fitting Type: Flush
 3. Housing: Satin aluminum
 4. Configuration: One receptacle and provisions for communication outlets
 5. Manufacturers: Hubbell, Legrand/Wiremold, FSR; Approved equal

2.014 MULTISERVICE FLOOR BOXES

- A. Above Grade: Stamped steel, watertight design approved for use on above-grade concrete floor applications, with four independent wiring compartments and capacity for up to four duplex receptacles and/or communication services. The box: fully adjustable providing pre-pour and after-pour adjustment, tunnel compartment, and two receptacle brackets. Conduit knockouts per drawing requirements. Comply with UL 514A and UL 514C scrub water exclusion test for tile, terrazzo, carpet and wood floors.
- B. On Grade: Cast iron or steel pour box, watertight design approved for use in on-grade and above-grade concrete floor applications, with four independent wiring compartments and capacity for up to four duplex receptacles and/or communication devices. The box: fully adjustable providing pre-pour and after-pour adjustment, tunnel compartment, and two receptacle brackets. Conduit knockouts per drawing requirements. Comply with UL 514A and UL 514C scrub water exclusion test for tile, terrazzo, carpet and wood floors.
- C. Covers: Activation Covers – Die-cast aluminum with textured aluminum finish, and black or brass powder-coated paint finishes as selected by the Architect. Cover: flanged or flangeless, as required, with options for tile or carpet inserts, blank covers, or covers with one or two 1" liquid tight conduit openings for furniture feed applications.
- D. Communication Modules Mounting Accessories: Complete line of faceplates and bezels provided by floor box manufacturer to facilitate mounting of fiber optic, coaxial, high-performance twisted-pair cabling, and communication devices. Cabling type and faceplate configurations per requirements in Section 27 1500 – Communications Horizontal Cabling. The box shall accommodate workstation connectivity outlets and modular inserts and other system devices.
- E. Manufacturers:
 - 1. Hubbell - HBLCFB Series
 - 2. Spider - AFB/CFB Series
 - 3. Legrand/Wiremold - Evolution Series

2.015 RACEWAY PENETRATION SEALS

- A. Thruwall and Floor Seals.
- B. Manufacturers: New construction – OZ/Gedney FSK Series; existing construction – OZ/Gedney CSM Series; or equivalent by manufacturer listed in 2.1.F.

2.016 RACEWAY SEALING FITTINGS

- A. For one through four conductors: Manufacturers: OZ/Gedney CSB Series; Approved equal
- B. For greater than four conductors: Manufacturers: OZ/Gedney EYA Series with sealing compound; Approved equal
- C. Low-temperature or hazardous locations: Manufacturers: OZ/Gedney EYA Series with sealing compound; Approved equal

2.017 CABLE SUPPORTS

- A. Manufacturers: OZ/Gedney Type S; or equivalent by manufacturer listed in 2.1.F.

2.018 SLEEVES FOR RACEWAYS

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends, with integral water stop.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052" or 0.138" thickness and of length to suit application.
- C. Integral Water Stop: Manufacturer: Thunderline Corporation; Approved equal
 - 1. High density polyethylene (HDPE). Type Century-Line engineered sleeve with end caps.
 - 2. Steel. Type WS engineered sleeve.

2.019 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 2. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.01 COORDINATION

- A. Coordinate with Architect/Engineer size and location of required built-in openings in building structure, including those sleeved, formed or core drilled.
- B. Coordinate with Architect/Engineer cutting, removing, or piercing general or mechanical insulation, fire-rated walls, ceilings or steelwork.
- C. Verify with Architect/Engineer all surface raceway installations except in mechanical, electrical, and communications rooms.
- D. Coordinate with Architect/Engineer exact locations of floor boxes, where shown on drawings, prior to rough-in.
- E. Coordinate routing of through-roof conduits.
- F. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 26 0593 – Electrical Systems Firestopping.
- G. Verify that exterior wall or wet location boxes are gasketed type cast boxes with matching cover.
- H. Verify with manufacturer that “touch-up” paint kit and PVC-coating kit are available for use.

3.02 EXAMINATION

- A. Examine surfaces to receive raceways and boxes for compliance with installation tolerances and other conditions affecting performance of raceway’s installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.03 INSTALLATION

- A. Raceways:
 - 1. Comply with ANSI/NECA 1 and NFPA 70 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this Section are stricter.
 - 2. Arrange raceways to maintain headroom and present neat appearance.
 - 3. Raceway routing is shown in approximate locations, unless dimensioned. Route to complete raceway installation before starting conductor installation.
 - 4. Keep raceways at least 6” away from parallel runs of flues, steam, hot-water pipes or ductwork. Install horizontal raceway runs above water and steam piping. Install raceways level and square and at proper elevations: 6’-6” minimum headroom, except in exit pathways 7’-0” minimum headroom. Do not block access to junction boxes, mechanical equipment or prevent removal of ceiling panels, etc.
 - 5. Run raceways concealed in construction to avoid adverse conditions such as heat and moisture, to permit drainage, and to avoid materials and equipment of other trades, except where noted otherwise.
 - 6. Avoid exposed raceway runs. Run raceways exposed where impractical or impossible to conceal or where specific approval is obtained. Run exposed raceways grouped and parallel or perpendicular to construction. Do not route exposed raceways over boilers or other high-temperature machinery or in contact with such equipment. Offset exposed raceways at boxes.

7. Route raceways installed above accessible ceilings parallel or perpendicular to construction.
8. Do not install raceways in structural or topping floor slabs, except where noted on the plans. Install raceway in structural or topping floor slabs, where noted on plans, as follows:
 - a. Center raceways in structural slabs clear of reinforcing steel, except where crossing same, and spaced on centers equal or exceeding 3 times the raceway diameter. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in concrete.
 - b. Outside diameter of raceway shall not exceed 1/3 the structural slab thickness.
 - c. Obtain approval from Engineer for each run of raceway 1" or larger.
 - d. Do not install raceways in topping slabs of 2" or less.
 - e. Locate raceways to avoid conflict with equipment, door bucks, partitions and other equipment bolted to floor.
 - f. Arrange stub-ups so curved portions of bends are not visible above finished slab. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; use flexible metal conduit 6" above the floor. Install threaded plugs flush with floor for future equipment connections.
 - g. Change from nonmetallic raceway to RMC or IMC before rising above floor.
9. Cut raceways square using saw or pipecutter.
10. Use hydraulic one-shot raceway bender or factory elbows for bends in raceway larger than 2", unless sweep elbows required. Bend raceways according to manufacturer's recommendations. Do not use torches or open flame to aid in bend of PVC conduit.
11. Use raceway fittings compatible with raceways and suitable for use and environment.
12. Provide bushings on all raceways 1-1/2" and larger.
13. Raceways minimum sizes:
 - a. Minimum raceway size 3/4", except as noted on drawings.
 - b. Minimum home run size: 3/4", except as noted on drawings.
 - c. Minimum size for flexible metal conduit is 1/2" except 3/8" for luminaires.
 - d. Minimum size for liquidtight flexible metal conduit is 1/2"
14. Install empty raceways 2-1/2" and larger with 10 ga galvanized fishwire; install 200 lb nylon pull cord in raceways smaller than 2-1/2"; leave at least 12" of slack at each end of pull wire. Cap raceways at both ends.
15. Feed devices on same wall vertically from above or junction box in suspended ceiling.
 - a. Do not install horizontal bends in conduit around corners.
 - b. Feed devices in exterior or load-bearing walls by horizontal conduit runs.
 - c. Where horizontal conduit runs are required or allowed, install conduits from device to device on same wall.
16. Raceways Supports:
 - a. Independently support or attach raceway system to structural parts of construction. Suspended ceiling systems shall not be considered as structural parts of construction for raceway support. Do not attach raceways to piping system.
 - b. Raceway supports for horizontal or vertical single runs:
 - 1) Hot dipped galvanized heavy-duty sheet steel straps, mineralac clamps or steel slotted support channel system with appropriate components.
 - 2) Spring steel type pressure clamps for raceways 3/4" and smaller.
 - c. Raceway supports for horizontal and vertical multiple runs:
 - 1) Trapeze-type supports fabricated with steel slotted channel systems with appropriate components.
 - 2) Support horizontal runs with appropriately sized rods.

- 3) Anchor vertical runs to structure.
 - 4) Spring-steel type pressure clamps for raceways 3/4" and smaller.
 - d. Vertical raceway runs 1-1/4" and larger passing through floors: Support at each floor with pipe riser clamps.
 - e. Do not support raceways with wire, perforated pipe straps or plastic tie-wrap. Remove wires used for temporary support.
 - f. Secure raceways in metal stud walls to prevent rattling.
 - g. Arrange raceway supports to prevent misalignment during wiring installation.
 - h. Do not fasten raceways to corrugated metal roof deck.
 - i. For fasteners and supports, including steel slotted support systems, support devices, support spacing, support of conductors in vertical raceways, and hanger rod size, refer to Section 26 0529 – Hangers and Supports for Electrical Systems and NFPA 70.
17. Identify raceways per requirements in Section 26 0553 – Electrical Systems Identification.
18. Ground raceways per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.
19. Flexible Conduit Connections: Use maximum of 72" of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for motors.
- a. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
20. Install PVC-coated raceways in areas with corrosive atmosphere.
21. Use tools approved for use with PVC coated conduits and fittings.
22. Install stainless steel raceway clamps, mounting hardware, supports, hangers, etc., when located in "wet" or "wash-down" areas.
23. Communications Raceways:
- a. Minimum communications raceway size: 1", unless otherwise noted on drawings.
 - b. Install one raceway from each communications outlet box. Horizontal raceway runs between wall outlet boxes are not allowed.
 - c. Terminate raceway on cable tray.
 - d. Install insulated bushings on end of each raceway.
 - e. Use UL listed metallic grounding clamps, when terminating raceway on cable tray.
 - f. Install flush two-gang box with single-gang trim ring for each communications outlet or as noted on drawings.
 - g. Install with no more than 180 degrees of bends between pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
 - h. Conduit bend radii (minimum) shall be:
 - 1) Six (6) times internal conduit diameter for conduit 2" or less internal diameter.
 - 2) Ten (10) times internal conduit diameter for conduit greater than 2" internal diameter.
 - i. Conduit bends shall be smooth, even, and free of kinks or other discontinuities that may have detrimental effects on pulling tension or cable integrity during or after installation.
 - j. Do not install 90-degree condulets. Install continuous radius sweeps of 45° minimum for 90-degree bends.
 - k. Do not install continuous sections longer than 100 ft.
 - l. Install nylon pull cord in empty raceways. Leave at least 12" of slack at each end of pull wire. Cap raceways at both ends.
- B. Wireways:
- 1. Install in accordance with manufacturer's instructions.
 - 2. Use screws, clips and straps to fasten raceway channel to surfaces.

3. Mount plumb and level.
 4. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
 5. Supports: Per manufacturer's recommendations.
 6. Close ends of raceway channel and unused conduit openings.
- C. Boxes:
1. Install boxes to accommodate device indicated by symbol, in conformance with code requirements, number and size of conductors and splices and consistent with type of construction.
 2. Install the appropriate cover on surface-mounted boxes:
 - a. Raised device covers on 4" square and 4-11/16" boxes and handy box covers on handy boxes, etc.
 - b. Device covers that are square drawn or square cut on boxes in block.
 - c. Tile covers on boxes in tile.
 - d. Round drawn device covers on boxes in lath and plaster walls or dry wall only.
 - e. Set front edge of device boxes flush with finished wall surfaces except on walls of non-combustible materials where boxes may have maximum set back of 1/4". Secure flush-mounted box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
 3. Set outlet boxes parallel to construction and independently attached to same.
 4. Do not install back-to-back and through-the-wall boxes. Install with minimum 6" horizontal separation between closest edges of the boxes. Install with minimum 24" separation in acoustic-rated walls and fire-rated walls.
 5. Install multi-ganged boxes where 2 or more devices are in same location, unless otherwise noted.
 6. Box Support:
 - a. Mount boxes straight.
 - b. Install horizontal bracing at top or bottom of box for 3 or more gang device boxes in stud walls.
 - c. Install stud support one side, with short piece of stud, for up to 2 gang device boxes.
 - d. Do not support boxes with tie-wire.
 - e. For one and two gang box support, manufactured bracket supports shall be accepted alternate.
 - f. Support boxes independently of raceways.
 - g. Install adjustable steel channel fasteners for hung ceiling outlet box.
 - h. Install stamped steel bridges to fasten flush-mounted outlet box between studs.
 - i. Do not install boxes to ceiling support wires or piping systems.
 7. Install partitions in multi-ganged boxes where different types of devices are installed, or devices installed operate at different voltages.
 8. Mount boxes in block walls at block joint nearest to indicated height.
 9. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
 10. When boxes are installed in fire-resistive walls and partitions, provide 24" horizontal separation between boxes on opposite sides of a wall. In addition, limit penetrations to 16 sq in per penetration and not to exceed a total of 100 sq in per 100 sq ft of wall area. Apply fire stop putty pads acceptable to the fire marshal.
 11. Pull and junction boxes: Install as shown, or as necessary to facilitate pulling of wire and to limit number of bends within code requirements. Install above accessible ceilings and in unfinished areas.
 12. Install boxes to be permanently accessible.

13. Do not intermix conductors from more than one system in same junction box or pull box, unless shown or specifically authorized otherwise.
 14. Adjust box location up to 10' prior to rough-in to accommodate intended purpose.
 15. Orient boxes to accommodate wiring devices oriented as specified in Section 26 2726 – Wiring Devices.
 16. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6" from ceiling access panel or from removable recessed luminaire.
 17. The drawings do not necessarily show every outlet, pull or junction box required. Add all required boxes as necessary.
- D. Outlet Boxes for Communications:
1. Install communications outlet boxes for each communications outlet, or as noted on drawings.
 2. Coordinate with other trades to maintain 8" clear space (minimum, measured from box centerline) on all sides of wall-mounted telephone outlet box.
- E. Pull and Junction Boxes for Communications:
1. Position Communications Pull and Junction Boxes:
 - a. In any section of conduit longer than 100 ft
 - b. Where there are bends totaling more than 180 degrees between pull points or pull boxes
 - c. Wherever there is a reverse bend in run
 2. Do not use pull boxes in place of bends on straight section of raceway, unless otherwise shown on drawings.
- F. Floor Boxes:
1. Set metal floor boxes level and flush with finished floor surface.
 2. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
 3. Use cast floor boxes for installations in slab on grade.
 4. Install floor boxes and fittings to preserve fire-resistant rating of slabs and other elements, using materials and methods specified in Section 26 0593 – Electrical Systems Firestopping.
 5. Identify communication outlets per requirements in Section 27 0553 – Communications Systems Identification.
 6. Power and IT or AV conduits require a minimum 12" separation where routed parallel including entry into floor boxes.
- G. Expansion Fittings:
1. Install raceway expansion and deflection fittings in all raceway runs embedded in or penetrating concrete where movement perpendicular to axis of the raceway may be encountered.
 2. Install raceway expansion fittings complete with bonding jumpers in raceway runs that cross expansion joints in structure and raceway runs mechanically attached to 2 separate structures.
 3. Use couplings and flexible connection made up of 24" length of flexible metal conduit, where EMT runs across expansion joints in ceiling spaces.
 4. Install fitting(s) that provide expansion and contraction for at least 0.0004" per ft of length of straight run per °F of temperature change.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation.
- H. Raceway Penetration Seals:

1. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
 2. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Maintenance of Joint Protection" for materials and installation.
 3. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials.
 4. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
 5. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1" annual clear space between pipe and sleeve for installing mechanical sleeve seals.
 6. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1" annual clear space between raceway and sleeve for installing mechanical sleeve seals.
 7. Sleeve-Seal Installation: Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 8. Provide chrome- or nickel-plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor's closets, storage rooms, etc., unless suspended ceilings are specified.
 9. Remove temporary sleeves, if used for form wall openings, prior to installation of permanent materials.
- I. Raceway Sealing Fittings:
1. Install listed watertight seals to prevent the passage of moisture and water vapor through raceway, where raceway passes from interior to exterior of the building, where raceway passes between areas of different temperatures such as into or out of cold rooms or freezers, where raceway enters room which at any time is subject to low or high temperatures and where raceway enters a room which at any time is subject to internal air pressures above or below normal.
 2. Install watertight seals in interior of all raceways passing through building roof, ground floor slab (when the raceway does not extend beyond building footprint), or through outside walls of building above or below grade. Seal on the end inside building, using raceway sealing fittings manufactured for the purpose. Locate fittings at suitable accessible locations. For concealed raceways install each fitting in flush steel box with blank coverplate to match finish of adjacent plates or surfaces.
 3. Seal raceways entering or passing through "hazardous (classified) areas" as defined in NFPA 70.
- J. Sleeve Installation for Electrical Penetrations:
1. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 26 0593 – Electrical Systems Firestopping.
 2. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
 3. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 4. Rectangular Sleeve Minimum Metal Thickness:

- a. For sleeve cross-section rectangle perimeter less than 50" and no side greater than 16", thickness shall be 0.052".
- b. For sleeve cross-section rectangle perimeter equal to, or greater than, 50" and 1 or more sides equal to, or greater than, 16", thickness shall be 0.138".
5. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies, unless openings compatible with firestop system used are fabricated during construction of floor or wall.
6. Cut sleeves to length for mounting flush with both surfaces of walls.
7. Extend sleeves installed in floors 2" above finished floor level.
8. Size pipe sleeves to provide 1/4" annular clear space between sleeve and raceway, unless sleeve seal is to be installed.

3.04 APPLICATION

A. Provide raceways and boxes in accordance with the following table:

Application	Approved Raceways	Approved Boxes	Application Notes
Underground More than 5 ft outside Foundation Wall	Rigid Steel Conduit, plastic-coated or Schedule 40 PVC	Cast Metal Boxes or Nonmetallic Handholes	
Underground Within 5 ft from Foundation Wall	Rigid steel conduit	Cast Metal Boxes or Nonmetallic Handholes	
In or Under Slab on Grade	Rigid Steel Conduit or Schedule 40 PVC	Cast or Nonmetallic boxes	Use steel elbows with RNC when encased in concrete
Outdoor Locations, Above Grade	Rigid Steel Conduit	Cast Metal or Nonmetallic	
In Slab Above Grade	Rigid Steel Conduit	Cast Metal	
Wet and Damp Locations	Rigid Steel Conduit	Cast Metal or Nonmetallic. Install flush mounting outlet boxes in finished areas	
Concealed Dry Locations	Electrical Metallic Tubing	Sheet Metal Boxes; Install flush mounting outlet boxes in finished areas; Install hinged enclosure for large pull boxes.	
Exposed Dry Locations	Rigid Steel conduit or Intermediate Metal Conduit	Sheet Metal boxes; Install flush mounting outlet boxes in finished areas; Install hinged	

Application	Approved Raceways	Approved Boxes	Application Notes
		enclosure for large pull boxes.	
Exposed Subject to Damage	Rigid Steel Conduit	Cast Metal	
Locations requiring Mechanical Protection	Rigid Steel Conduit, Intermediate Metallic Conduit		
Corrosive Atmospheres	PVC Coated Conduit		Use PVC Coated Elbows with PVC Conduits
Vibrating equipment (including transformers & hydraulic, pneumatic, electric solenoid or motor-driven equipment)	Flexible Metal Conduits (FMC) – Dry Locations Only Liquid Tight Flexible Metal Conduits (LFMC) – Wet Locations		Lengths for FMC & LFMC may range between 2 ft to 4 ft

B. Special Conditions

1. One-half inch raceway permitted:
 - a. Between controller and its control or pilot device
 - b. Between lighting switch and nearest outlet for luminaire
 - c. Control wiring where mounted on equipment where conduit must follow contour of equipment
 - d. Protective and signal systems where noted
 - e. Where shown on plans

3.05 FIELD QUALITY CONTROL

- A. Inspect raceway, boxes, and wireways for physical damage and proper alignment.
- B. Replace any damaged component of the raceway system or install new raceway system.
- C. Inspect components, wiring, connections and grounding.

3.06 REPAINTING

- A. Repair damage to galvanized finishes with manufacturer-supplied zinc-rich paint kit. Leave remaining paint with Owner.
- B. Repair damage to PVC or paint finishes with manufacturer-supplied touch-up coating. Leave remaining coating with Owner.
- C. Wireways, indoor service poles: Remove paint splatters and other marks from surface; touch-up chips, scratches, or marred finished to match original finish using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.07 ADJUSTING

- A. Adjust flush-mounted boxes pre-pour and after-pour to be flush with finished materials.
- B. Install knockout closures in unused openings in boxes.
- C. Align adjacent wall-mounted outlet boxes for switches and similar devices.
- D. Adjust outlet boxes to allow luminaires to be positioned as indicated on reflected ceiling plan.

3.08 CLEANING

- A. Clean interior and exterior of boxes, wireways, and indoor poles to remove dust, debris and other material.

END OF SECTION

SECTION 26 0533.13
SURFACE RACEWAY SYSTEM

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 0526 – Grounding and Bonding for Electrical Systems
- C. Section 26 0553 – Electrical Systems Identification
- D. Section 26 2726 – Wiring Devices
- E. Section 27 0553 – Communications Systems Identification
- F. Section 27 1500 – Communications Horizontal Cabling

1.02 DESCRIPTION

- A. Section includes surface metallic raceway system for branch circuits, data network, and other low-voltage wiring.
- B. Surface raceway system shall consist of raceway bases, appropriate fittings, and device mounting plates necessary for a complete installation.
- C. The lengths of the raceways shown on drawings are illustrative and diagrammatic only and should not be used for material takeoff. Raceways shall be provided completely installed to match lengths of cabinets and shelving as indicated on (laboratory) casework shop drawings. Receptacle circuits shall be pre-wired.

1.03 REFERENCE STANDARDS

- A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting
- B. NFPA 70 – National Electrical Code
- C. UL 5 - Surface Metal Raceways and Fittings
- D. UL 5A - Nonmetallic Surface Raceways and Fittings
- E. UL 94 – Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.04 SUBMITTALS

- A. Product Data: Catalog cuts of components.
- B. Shop Drawings:
 - 1. Complete layout, with locations of raceway components.
 - 2. Grounding, branch circuiting, and wiring including locations of service entrances.
 - 3. Receptacle types, manufacturers, and spacing.
 - 4. Receptacle labeling with proper voltage, phase, circuit and panelboard designations, as indicated on drawings.
 - 5. Communication faceplate types, manufacturers and labeling.
- C. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- D. Closeout Submittals:
 - 1. Project Record Documents
 - a. Record actual locations of surface raceways with receptacle types, locations and circuits identified.
 - 2. Operation and Maintenance Data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
 - b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.05 QUALITY ASSURANCE

- A. Obtain surface raceways from one source and by single manufacturer.

- B. Regulatory Requirements:
 - 1. Comply with NFPA 70 for components and installation.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.
- B. Comply with manufacturer's written instructions.

1.07 WARRANTY

- A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Metallic Raceways:
 - 1. Hubbell
 - 2. Legrand/Wiremold
 - 3. Mono-Systems

2.02 FABRICATION

- A. UL 5, UL 5A, as applicable
- B. Fabrication:
 - 1. Aluminum
 - 2. Suitable for use in dry interior locations only.
 - 3. Two-compartment raceway with separate cover for each compartment, same size as Wiremold Isoduct ALA4800 Series.
 - 4. Covers with cutouts for device plates as shown on drawings.
 - 5. 6" and 12" long device plates with flange to overlap joint of adjacent cover.
- C. Prewired Raceways:
 - 1. Wiring devices factory installed, wired, and covers labeled with panel number and circuit number, voltage, phase, and amperes, as identified on drawings, per requirements in Sections 26 0519 – Low-Voltage Electrical Power Conductors and Cables and 26 2726 – Wiring Devices.
 - 2. Raceway sections with 12" pigtails at feed locations, in 2 ft minimum length and customized to match length shown on drawings.
 - 3. Equivalent distance between receptacles; number of receptacles per length of raceway as shown on drawings.
 - 4. Factory installed, NFPA 70 sized, grounding conductors, per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.
 - 5. Raceway covers with hole-cut provisions for communication outlets.
 - 6. Wiring devices on top and communication outlets on bottom.
- D. Material:
 - 1. Aluminum Raceways: Alloy 6063-T5 extruded aluminum, minimum thickness 0.060"
 - 2. Fittings: Same material and metal thickness as linear raceway components.
- E. Finish:
 - 1. Aluminum Raceways:
 - a. Satin, No. 204 clear anodized 0.004" thick, Class R1 Mil-Spec.
 - 2. Fittings: Color to match linear raceway components.

- F. Accessories:
 - 1. Fittings: Available as standard accessories, including external corner units, internal corner units, flat units, blank end units, internal and external elbows, coupling for joining raceway sections, and device mounting brackets and plates.
 - 2. Wire Clips: One for every 2 linear ft of indicated raceway configuration.
 - 3. Corner elbows and tee fittings, to maintain 2" cable bend radius that meets requirements for communications pathways and specifications for fiber optic, coaxial, and high-performance twisted-pair cabling.
 - 4. Device Mounting Brackets and Plates: Plastic device mounting brackets and trim plates allowing installation of indicated wiring devices, and communications outlets horizontally in raceways; trim cover sized to overlap device cut-out in raceway, concealing seams; finished to match linear raceway components; plastic compatible with UL 94; brackets and plates, to match raceway width, and with device mounting holes.
- G. Communications Outlets and Accessories:
 - 1. Cabling Type: Per requirements in Section 27 1000 – Structured Cabling and Section 27 1500 – Communications Horizontal Cabling.
 - 2. Mounting faceplates and bezels: Faceplates configuration per requirements in Section 27 1000 Structured Cabling and Section 27 1500 – Communications Horizontal Cabling.

PART 3 - EXECUTION

3.01 COORDINATION

- A. Coordinate cover plate openings with the wiring devices contained within.
- B. Coordinate cover plate openings with the communications outlets contained within, to provide for one opening for each communication symbol shown on drawings in Division 27. Coordinate device plate sizes (single-gang or two-gang) to accept communication faceplate types specified in Section 27 1000 – Structured Cabling and Section 27 1500 – Communications Horizontal Cabling.
- C. Verify with manufacturer that 'touch-up' paint kit is available for repainting.
- D. Coordinate surface raceways installation with (laboratory) casework shop drawings to match lengths of cabinets and shelving.
- E. Verify location of raceways with architectural interior elevation drawings.

3.02 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect/Engineer of unsatisfactory preparation before proceeding.

3.03 INSTALLATION

- A. Install in accordance with ANSI/NECA 1 and manufacturer's instructions.
- B. Install flathead screws, clips and straps to fasten surface raceways to substrates, ensuring they are permanently and mechanically anchored. Double-sided adhesive is not acceptable. Mount plumb and level. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- C. Install wiring devices and communications outlets of type, quantity and spacing as indicated on drawings.
- D. Mount raceways on wall parallel to or at right angles to structure and casework.
- E. Feed raceways mounted on walls from a backbox through a wall box connector. Determine point of feed in field and complete wiring connections.
- F. Maintain ground continuity throughout entire raceway length per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.
- G. Do not field cut prewired raceways.

- H. Install appropriate backbox extension rings where raceway is mounted to steel slotted channel or by some other method, stood off from wall.
- I. Raceway receptacle faceplates shall be labeled with adhesive labels with 1/4" high lettering, per requirements in Section 26 0553 – Electrical Systems Identification, indicating receptacle voltage, phase, and amperage (i.e., 120V, 1-phase, 20A) at top of receptacle, and panel and circuit designation (i.e., NLP-D2-2/12) at bottom of receptacle, in accordance with requirements in Section 26 0553 – Electrical Systems Identification, for 15A, 20A and 30A receptacles.
- J. Reinforce each cover section for every 30A receptacle in raceway with two 4-40 Phillips counter-sunk steel screws attached to enclosure near top and bottom of receptacle.
- K. Identify communication outlets per requirements in Section 27 0553 – Communications Systems Identification.
- L. Raceway base shall be secured using screws. Securing with double-sided adhesive is not acceptable.

3.04 FIELD QUALITY CONTROL

- A. Inspect surface raceways for physical damage and proper alignment.
- B. Inspect components, wiring, connections, installation, and grounding.

3.05 REPAINTING

- A. Remove paint splatters and other marks from surface of equipment.
- B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.06 CLEANING

- A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION

**SECTION 26 0553
ELECTRICAL SYSTEMS IDENTIFICATION**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0516 – Owner Furnished Equipment
- B. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables
- C. Section 26 0533 – Raceways and Boxes for Electrical Systems
- D. Section 26 0573 – Power System Studies
- E. Section 26 0923 – Lighting Control Devices
- F. Section 26 2200 – Low-Voltage Transformers
- G. Section 26 2416.13 – Lighting and Appliance Panelboards
- H. Section 26 2416.16 – Distribution Panelboards
- I. Section 26 2726 – Wiring Devices
- J. Section 26 2816 – Enclosed Switches and Circuit Breakers
- K. Section 26 2913 – Enclosed Controllers
- L. Section 26 3213 – Engine Generators
- M. Section 26 3623 – Automatic Transfer Switches
- N. Section 26 4300 – Surge Protective Devices
- O. Section 28 3113 – Fire Detection and Alarm Systems

1.02 DESCRIPTION

- A. Section includes the following:
 - 1. Identification for raceway and metal-clad cable
 - 2. Identification for conductors and communication and control cable
 - 3. Underground-line warning tape
 - 4. Warning labels and signs
 - 5. Instruction signs and posted drawings
 - 6. Equipment identification nameplates
 - 7. Wiring devices identification
 - 8. Miscellaneous identification products
- B. Refer to the respective Division 26 Sections, and Sections in other Divisions that specify electrical components, for additional electrical identification requirements.

1.03 REFERENCE STANDARDS

- A. ANSI A13.1 – Scheme for the Identification of Piping Systems
- B. ANSI C2 – National Electrical Safety Code
- C. ANSI Z535.4 – National Standards for Product Safety Signs and Labels
- D. 29 CFR – Labor, Part 1910 – Occupational Safety and Health Standards, Section 1910.145 – Specifications for Accident Prevention Signs and Tags
- E. NFPA 70 – National Electrical Code

1.04 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Torque log for all terminations 100A and over. Log shall identify target torque values, as they are found via manufacturer documentation and individual locations.
- C. Nameplate Schedule: Prior to making nameplates, submit a complete schedule to Architect for approval indicating nameplate size, lettering size, color and actual nameplate information.
- D. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.05 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.

- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.06 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MSI), Seton, or approved equal.
- C. Color for Printed Legend:
 - 1. Power Circuits: Black letters on an orange field.
 - 2. Legend: Indicate system or service and voltage, if applicable.
- D. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- E. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action when placed in position.
- F. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2" long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action when placed in position.
- G. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2" wide; compounded for outdoor use.

2.02 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend.
- B. Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MRI), Seton, or approved equal.
- C. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1" to 2" wide.
- D. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- E. Aluminum Wraparound Marker Labels: Cut from 0.014" thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- F. Metal Tags: Brass or aluminum, 2" x 2" x 0.05", with stamped legend, punched for use with self-locking nylon tie fastener.
- G. Write-On Tags: Polyester tag, 0.010" thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
- H. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.

2.03 UNDERGROUND-LINE WARNING TAPE

- A. Manufacturers: Ideal, Marking Services, Inc. (MRI), Seton, or approved equal.
- B. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1. Not less than 6" wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip.
 - 4. Printed legend shall indicate type of underground line.
 - 5. Red tape for electrical and orange tape for communications / controls installations.

2.04 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Self-Adhesive Arc Flash Warning Labels: Industrial grade, made of durable polyester with over-laminate to withstand harsh environments (UV rays, scratches and most chemicals).
 - 1. Manufacturer: Seton or approved equal
- D. Engraved Plastic Signs: Engraving stock, melamine plastic laminate, minimum 1/16" thick for signs up to 20 sq in and 1/8" thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
- E. Baked-Enamel Warning Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4" grommets in corners for mounting. Nominal size, 7" x 10".
- F. Metal-Backed, Butyrate Warning Signs for Exterior Use: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396" galvanized-steel backing; and with colors, legend, and size required for application. 1/4" grommets in corners for mounting. Nominal size, 10" x 14".
- G. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING – OSHA REGULATION – AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
 - 3. Arc Flash Labels: Per ANSI Z535.4, the signal word WARNING appearing in black letters on an orange background, with second line below (Arc Flash and Shock Hazard) in black letters on white background and third line below (Appropriate PPE Required) in black letters on white background. Include the following information on the label:
 - a. Equipment name
 - b. Available bolted current
 - c. Flash protection boundary distance
 - d. Incident energy level at 18" expressed in cal/cm²
 - e. Personnel protective equipment (PPE) class
 - f. Voltage shock hazard
 - g. Limited shock approach boundary
 - h. Restricted shock approach boundary

2.05 TORQUE MARKING

- A. Contractor shall keep a log of torque values used for project. This record shall incorporate name of installer for each specific location with date/time.

- B. Torque marks shall be made on nut side and extend to a non-rotating surface. Torque marks shall be made at time of torquing – placing torque marks after the fact is not permitted, but instead must be re-torqued and marked.
- C. Permanent marker: Contractor shall confirm torque requirements with manufacturer and use tools calibrated within past 6 months. Terminations over 100A shall have black permanent marker utilized for visual confirmation.

2.06 INSTRUCTION SIGNS AND POSTED DRAWINGS

- A. Instruction Signs: Engraved, laminated acrylic or melamine plastic, minimum 1/16" thick for signs up to 20 sq in and 1/8" thick for larger sizes.
 - 1. Engraved legend with black letters on white face
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Mounting Frames: Extruded aluminum, 4-point screw mount with 1/8" clear plexiglass cover.
- B. Posted Drawings: Print electrical riser diagrams on 20 lb bond paper. (Blueprint paper is not acceptable.) Reduce drawings to approximately 1/2 size using Xerox reduction process. Contact Engineer to obtain updated original plans for printing.

2.07 EQUIPMENT IDENTIFICATION NAMEPLATES

- A. Engraved, Three-layer, Laminated Acrylic or Melamine Nameplate: Punched or drilled for screw mounting. White letters on a black background, except emergency power equipment nameplates are to have white letters on a red background. Minimum letter height shall be 3/8" unless noted otherwise.
- B. Stenciled Legend: In non-fading, waterproof, black ink or oil-based, alkyd enamel paint. Minimum letter height shall be 1".

2.08 WIRING DEVICES IDENTIFICATION

- A. Refer to Section 26 2726 – Wiring Devices for requirements.

2.09 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16"
 - 2. Tensile Strength: 50 lb minimum
 - 3. Temperature Range: -40°F to 185°F
 - 4. Color: Black, except where used for color-coding
- B. Paint: Paint materials and application requirements are specified in Division 09 – Finishes painting Sections.
- C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Raceway and Ductbanks More Than 600 V Concealed within Buildings: 4" wide black stripes on 10" centers over orange background that extends full length of raceway or duct and is 12" wide. Stencil legend "DANGER CONCEALED HIGH-VOLTAGE WIRING" with 3" high black letters on 20" centers. Stop stripes at legends. Apply to the following finished surfaces:
 - 1. Floor surface directly above conduits running beneath and within 12" of a floor that is in contact with earth or is framed above unexcavated space.
 - 2. Wall surfaces directly external to raceways concealed within wall.
 - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A: Identify with orange self-adhesive vinyl labels.

1. Identify 4" round, 4" square and 4-11/16" junction boxes concealed above ceiling or exposed with neat lettering on cover with permanent black marking pen. Identify source, circuit number, phase, and control circuit number.
- C. Accessible Raceways and Cables of Auxiliary Electrical Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
 1. Fire Alarm System (including covers of pull and junction boxes): Red
- D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape or write-on tags. Identify each ungrounded conductor according to source and circuit number.
- E. Conductors to Be Extended in the Future and Spare Conductors: Attach write-on tags to conductors and list source and circuit number.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with project drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
- H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access to equipment.
 1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches
 - b. Controls with external control power connections
 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
 3. Arc Flash Warning Labels: install per NFPA 70 for each switchgear, switchboard, panelboard, motor control center, industrial control panel (every enclosure that may contain energized conductors or components). Locate labels so they are visible to the personnel before examination, adjustment, servicing, or maintenance of the equipment.
 4. Available Fault Current Labels: install per NFPA 70 for each piece of service entrance equipment. Locate labels so they are visible to the personnel before examination, adjustment, servicing or maintenance of the equipment.
- I. Instruction Signs and Posted Drawings:
 1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend printed in all capital letters of 12 pt size minimum where instructions are needed for system or equipment operation.
 2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8" high letters for emergency instructions at equipment used for power transfer.
- J. Emergency Electrical System Junction and Pull Boxes:
 1. Identify with spray-painted covers as follows:
 - a. Emergency circuits: Green/Yellow

- b. Standby circuits: Yellow
- K. Equipment Identification Nameplates: On each unit of equipment, install unique designation nameplate that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply nameplates to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Nameplate Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine nameplate. Unless otherwise indicated, provide a single line of text with 1/2" high letters (1/4" where space is limited) on 1-1/2" high nameplate; where 2 lines of text are required, use nameplates sized 2" high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine nameplates sized similar to indoor equipment nameplates.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - 2. Install nameplates for equipment including, but not limited to, the following:
 - a. Panelboards, electrical cabinets, and enclosures
 - b. Access doors and panels for concealed electrical items
 - c. Electrical distribution panelboards including each feeder device within the equipment enclosures.
 - d. Transformers
 - e. Emergency system boxes and enclosures
 - f. Disconnect switches
 - g. Enclosed circuit breakers
 - h. Motor controllers
 - i. Pushbutton stations
 - j. Power transfer equipment
 - k. Contactors
 - l. Remote-controlled switches, dimmer modules, and control devices
 - m. Power-generating units
 - n. Monitoring and control equipment
 - o. Terminals, racks, and patch panels for voice and data communication and for signal and control functions
 - p. Non-concealed junction box covers of auxiliary electrical systems
 - 3. Provide the following information on each nameplate:
 - a. Equipment name/tag:
 - 1) Matching the designation from the contract documents, or identifying the load controlled or function of the equipment where no specific tag is shown on the contract documents.
 - 2) For disconnect switches, use the prefix "SW-" followed by the name of the equipment served, example: "SW-PMP-201."
 - b. Equipment operating voltage, phase, wiring configuration, and ampacity:
 - 1) Example: "208V/3PH/4W/225A"
 - c. Source of power supply, including circuit number:
 - 1) Example: "FED FROM LP-2/45"
- L. For distribution boards and panelboards, provide a nameplate identifying the color code of wiring within the panel, including the following information:
 - 1. Heading "<PANEL VOLTAGE> CONDUCTOR COLOR CODING"
 - 2. PHASE A: <COLOR OF INSTALLED CONDUCTORS>

3. PHASE B: <COLOR OF INSTALLED CONDUCTORS>
 4. PHASE C: <COLOR OF INSTALLED CONDUCTORS>
 5. NEUTRAL: <COLOR OF INSTALLED CONDUCTORS>
 6. GROUND: GREEN>
- M. For service entrance equipment, provide a nameplate identifying the maximum available fault current and “as of” effective date.
1. Example: “MAXIMUM AVAILABLE FAULT CURRENT 33,500A AS OF 2021/06/15.”
- N. Access Panel Identification: Furnish typewritten charts with identification and location of access panels serving equipment and incorporate in O&M Manuals.

3.02 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Install non-adhesive signs and plastic nameplates parallel to equipment lines; attach with screws and auxiliary hardware appropriate to the location and substrate. Secure to inside surface of door or panelboard that is recessed in finished locations.
- F. Posted Drawings and Operating Instructions: Mount drawings and operating procedures on the wall immediately adjacent to the piece of equipment for which the instructions apply. If sufficient wall space is available, mount directly to one of the sheet metal panels of the equipment.
- G. Warning Signs: Install warning signs where there is hazardous exposure or danger associated with access to or operation of electrical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with ANSI A13.1 standard color and design.
1. Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical systems, provide tags of plasticized card stock, either preprinted or hand printed to convey the message; example: “DO NOT OPEN THIS SWITCH WHEN BREAKER IS CLOSED.”
- H. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.
- I. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
1. Color shall be factory applied, or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
 2. Colors for 208/120 V Circuits:
 - a. Phase A (left bus in panelboard): Black
 - b. Phase B (center bus in panelboard): Red
 - c. Phase C (right bus in panelboard): Blue
 - d. Neutral: White
 - 1) Dedicated neutral, Phase A; white with black tracer
 - 2) Dedicated neutral, Phase B: white with red tracer
 - 3) Dedicated neutral, Phase C: white with blue tracer
 - e. Equipment Ground: Green
 3. Colors for 480/277 V Circuits:
 - a. Phase A (left bus in panelboard): Brown

- b. Phase B (center bus in panelboard): Orange
 - c. Phase C (right bus in panelboard): Yellow
 - d. Neutral: Gray
 - 1) Dedicated neutral, Phase A; gray with brown tracer
 - 2) Dedicated neutral, Phase B; gray with orange tracer
 - 3) Dedicated neutral, Phase C; gray with yellow tracer
 - e. Equipment Ground: Green
4. Field-applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6" from terminal points and in boxes where splices or taps are made. Apply last two runs of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- J. Aluminum Wraparound Marker Nameplates and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- K. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6" to 8" below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16" overall.
- L. Painted Identification: Prepare surface and apply paint according to Division 09 – Finishes painting Sections.

END OF SECTION

SECTION 26 0923
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0000 - General Electrical Requirements
- B. Section 26 5000 - Lighting

1.02 DESCRIPTION OF SYSTEM

- A. Provide devices such as wall box dimmers, wall and ceiling mounted occupancy sensors, ambient light sensors, sensor power packs, etc., as shown on drawings.
- B. Openings shall be covered with devices and matching plates.
- C. Devices of same type shall be from same manufacturer.

1.03 REFERENCE STANDARDS

- A. UL20 - General Use Snap Switches.
- B. UL773A - Non-Industrial Photoelectric Switches for Lighting Control.
- C. UL924 - Emergency Lighting and Power Equipment
- D. NEMA WD 7 - Occupancy Motion Sensors.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings shall include:
 - 1. Bill of material
 - 2. Schematic diagrams
 - 3. Suggested manufacturer layouts of all devices including overlays of product range.
- C. Samples: One for each type of device and wall plate specified, in each color specified upon request.
- D. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
- F. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual locations and type of devices.
 - 2. Operation and Maintenance Data:
 - a. Include in manufacturers' packing label warnings and instruction manuals with labeling conditions.
 - b. Include source and current prices of replacement parts and supplies.

1.05 QUALITY ASSURANCE

- A. Obtain devices from one source and by single manufacturer.
- A. Regulatory Requirements:
 - 1. Comply with NFPA 70 for components and installation.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

1.07 WARRANTY

- A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.
- A. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers:
 - 1. Wall Box Dimmers: Acuity Brands Controls, Cooper Controls, Hubbell, Leviton, Lutron, Philips (Sunrise Series), Wattstopper
 - 2. Low Voltage Switches: Acuity Brands Controls, Cooper Controls, Hubbell, Leviton, Lutron, Philips, Wattstopper
 - 3. Sensors and Power Packs: Acuity Brands Controls, Cooper Controls, Hubbell, Leviton, Lutron, Philips, Wattstopper
 - 4. Exterior Occupancy Sensors: Acuity Brands Controls, Leviton, Wattstopper
 - 5. UL 924 Emergency Bypass/Control Device: Acuity Brands Controls, Hubbell, Leviton, Wattstopper, LVS
 - 6. Exterior Photocells: Cooper Controls, Hubbell, Intermatic, Leviton, Paragon, Tork
 - 7. Timeclocks: Intermatic, Paragon, Tork
 - 8. Self-Contained Automatic Timer Switches: Acuity Brands Controls, Cooper Controls, Hubbell, Leviton, Philips, Wattstopper
- B. It is the responsibility of Electrical Contractor to ensure devices submitted meet or exceed functional intent and design quality standards.

2.02 FABRICATION AND MANUFACTURE

- A. Devices shall be UL listed for loads and voltages as indicated in contract drawings and specifications.

2.03 WALL BOX DIMMERS

- A. Dimmers shall:
 - 1. Operate in ambient temperature range of 32°F to 104°F.
 - 2. Be linear slide or pushbutton preset or programmable dimmers with power-failure memory.
 - 3. Incorporate separate control of intensity and ON/OFF.
 - 4. Include voltage compensation circuitry that adjusts firing angle of dimmer to compensate light output for variations in AC line voltage. Dimmers in which firing angle is held constant with varying AC line voltage shall not be acceptable.
 - 5. Provide smooth and continuous IESNA Square Law Dimming Curve throughout entire dimming range.
 - 6. Incorporate filter network to minimize interference (RFI) with radio, audio, and video equipment.
 - 7. Incorporate air-gap switch to meet requirements of UL 20 for air-gap switches in incandescent dimmers.
- B. LED dimmers shall:
 - 1. Be approved for use with luminaire and driver.
 - 2. Provide smooth non-flicker dimming of controlled luminaires.
 - 3. Be 0-10V type, unless noted otherwise on drawings.
 - 4. Provide at least 10 steps for continuously dimmed luminaires.
 - 5. Refer to Section 26 5100 – Interior Lighting for solid state dimming ballast/driver specification.

2.04 LOW-VOLTAGE SWITCHES

- A. Low voltage switches shall:

1. Mount in a single or double gang box.
2. Be capable of multi-way switching.

2.05 OCCUPANCY AND VACANCY SENSORS

- A. Sensors shall:
1. Operate with all lamp and ballast combinations; including magnetic, hybrid, and solid-state ballasts/drivers.
 2. Operate with ultrasonic, microphonic, passive infrared or presence technologies as indicated on drawings.
 3. Have visible LED to indicate occupant detection.
 4. Have adjustable time delay with a maximum setting of 30 minutes and adjustable sensitivity.
 5. Contain isolated relay with normally open, normally closed, and common outputs for use with HVAC system, data logging, controlled receptacles or other system control options where indicated in contract documents.
 6. Be provided with ceiling, wall or wall switch style mounting as indicated on drawings.
 7. Have daylight filter to ensure PIR sensor is insensitive to short-wavelength waves emitted by the sun.
 8. Incorporate by-pass switch to enable lighting to be turned on if sensor fails.
- B. Occupancy Sensor shall:
1. Provide automatic ON, automatic OFF operation where indicated on drawings.
- C. Vacancy Sensor shall:
1. Provide manual ON, automatic OFF operation where indicated on drawings.

2.06 AMBIENT LIGHT SENSORS

- A. Ambient light sensors shall:
1. Incorporate photoconductive cell to measure light levels between 1 and 1,000 footcandles.
 2. Be adjustable with deadband feature to prevent cycling of lighting from minor changes in cloud cover.
 3. Have adjustable time delay range from 3 to 5 minutes.
 4. Not permit lighting systems to be turned on if enough daylight is present.
 5. Incorporate by-pass switch to enable lighting to be turned on if sensor fails.

2.07 POWER PACKS

- A. Sensor power packs shall:
1. Be self-contained transformer relay modules.
 2. Have universal rated voltage inputs 120-277 VAC, 60 Hz.
 3. Have normally closed dry contacts rated for switching 120-277 volts, 60 Hz. 20 amp loads. Provide 24VDC output capable of controlling low-voltage occupancy sensors.

2.08 EXTERIOR OCCUPANCY SENSORS

- A. Exterior occupancy sensors shall:
1. Be a completely self-contained device capable of detecting presence in the controlled range by detecting changes between infrared energy in motion and the background space.
 2. Utilize passive infrared detection technology and a three level Fresnel lens to increase detection density and accuracy of motion detection.
 3. Be capable of mounting vertically or horizontally onto a standard outdoor junction box or integral to exterior luminaires.
 4. Cover up to 35 ft with a field of view of 180 degrees or 52.5 ft with a field of view of 270 degrees.
 5. Have an operating temperature range of -40°F to 130°F.
 6. Be IP66 rated for outdoor applications.

7. Include a built-in light level sensor, adjustable by the user that will keep lights from turning on during daylight hours.
8. Have user-adjustable time delay settings, including an override ON option that enables controlled lights to be turned on remotely for the length of the time delay.
9. Be compatible with all electronic ballasts and LED drivers with no minimum load requirements.
10. Provide continuous dimming or bi-level control to reduce electric light levels from a minimum of 40% to a maximum of 80% based on area occupancy.

2.09 UL 924 EMERGENCY BYPASS/CONTROL DEVICES

- A. UL 924 listed bypass relays shall:
 1. Be UL924 listed and labeled for connection to both normal and emergency lighting power sources.
 2. Have universal rated voltage inputs 120-277 VAC, 60 Hz.
 3. Have normally closed dry contacts rated for switching 120-277 volts, 60 Hz. 20 amp loads.
 4. Have integral manual test switch.
 5. Have auxiliary isolated normally closed contact for connection to remote test switch, fire alarm system, or other external system capable of providing a normally closed dry contact closure.
 6. Have status indication for presence of normal and emergency power sources and current operational mode (normal or emergency).
 7. Utilize zero crossing circuitry to protect relay contacts from the damaging effects of inrush current generated by switching electronic ballast loads.
 8. Be forced into the emergency mode upon loss of normal power sense and turn ON the emergency lighting.
 9. Automatically switch emergency lighting ON/OFF as normal lighting is switched. When normal power is not available, the unit shall force and hold emergency lighting ON regardless of the state of any external control device until normal power is restored.
- B. Operational temperature range shall be -40°F to 140°F.
- C. Device shall have universal mounting; surface, above suspended ceiling or recessed.

2.010 EXTERIOR PHOTOCELLS

- A. Photocells shall:
 1. Have universal rated voltage inputs 120-277 VAC, 60 Hz.
 2. Be rated for up to 2,000 watts.
 3. Have cadmium sulfide, 1" diameter cell.
 4. Have SPST normally closed contacts.
 5. Have a minimum delay of 3 minutes to prevent false switching.
- B. ON/OFF adjustment shall be done by moving light selector with range from 2 to 50 footcandles.
- C. Operational temperature range shall be -40°F to 140°F.
- D. Enclosure shall be die cast zinc, gasketed for maximum weatherproofing.
- E. Enclosure shall include positioning lug on top.
- F. Mounting shall be for 1/2" conduit nipple.

2.011 TIMECLOCKS

- A. Timeclocks shall:
 1. Be multi-purpose, 7-day, 365-day advance single and skip a day, combination 2-channel electronic astronomical time clock with SPDT switching configuration.
 2. Have universal rated voltage inputs 120-277 VAC, 60 Hz.
 3. Be capable of programming in AM/PM or 24-hour format by jumper selection or digital setting, in one-minute resolution, using 2 buttons for basic settings.

4. Have 365-day and/or holiday selection capabilities, with 16 single date and 5 holiday selection options and user selectable daylight savings/standard time functions.
5. Have 72-hour memory backup with rechargeable battery and charger.
6. Have manual override, ON/OFF to the next scheduled event, using one button for each channel.
7. Have operational temperature range of -40°F to 150°F.
8. Have a maximum allowed over-ride period no greater than 2 hours.
- B. Contacts shall be rated 10 amp resistive at 120/250 VAC, 7.5 amps inductive at 120/250 VAC, 5 amps inductive at 30 VDC and up to 1/2 hp at 250 VAC.
- C. Display shall be LCD type.
- D. Enclosure shall be rated for installation location.

2.012 SELF-CONTAINED AUTOMATIC TIMER SWITCHES

- A. Timer switches shall:
 1. Have universal rated voltage inputs 120-277 VAC, 60 Hz.
 2. Be programmable to turn lights OFF after a preset time.
 3. Have a ground wire and ground strap for safety with a latching air gap relay switching mechanism.
 4. Use Zero Crossing Circuitry to increase the relay life, protect from the effects of inrush current.
 5. Be compatible with all electronic ballasts, motor loads, LEDs and LED drivers, compact fluorescent and inductive loads. Triac and other harmonic generating devices shall not be allowed.
 6. Have no minimum load requirement and shall be capable of controlling 0 to 800 watt incandescent, fluorescent @ 100/120 VAC, 50/60 Hz; 0 to 1200 watts fluorescent @ 230/277 VAC, 50/60 Hz; 1/6 hp @ 125 VAC. LED with internal or external driver @ 100/120VAC.
 7. Have the option for light flash warning at five minutes before the timer runs out and again when the countdown reaches one minute.
 8. Have the option for a beep warning that shall sound every five seconds once the time switch countdown reaches one minute.
 9. Have manual feature for timer reset where pressing the ON/OFF switch for more than 2 seconds resets the timer to the programmed time-out period.
 10. Have a feature that shows the timer's countdown.
 11. Have the calibration switch for setting time-out, time scroll, one second light flash, and beep warning shall be concealed to prevent tampering of adjustments and hardware.
 12. Have a maximum allowed over-ride period no greater than 2 hours.
 13. Be capable of operating as an ON/OFF switch.
 14. Utilize terminal style wiring.
 15. Have a 100% OFF override switch with no leakage current to the load.

2.013 FINISHES

- A. Color:
 1. Wall box dimmers, low-voltage switches, occupancy sensors, ambient light sensors and device cover plates: white.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install devices at heights scheduled, and as indicated on drawings.
- B. Install wall devices vertically on latch side of door within 6" of frame edge, unless otherwise noted.
- C. Install ceiling devices as shown on drawings and as recommended by device manufacturer.

- D. Ceiling mounted occupancy sensors shall be located minimum of 6 ft from supply air diffusers.
- E. Install devices plumb, level with finished surfaces and free from blemishes.
- F. Verify device locations prior to rough in.
- G. Control wiring shall be low voltage, Class II wiring, electrically isolated from power wiring by a Class II transformer.
- H. Provide separate neutral conductor for each dimmer.
- I. Wiring shall be in conduit.
- J. Electrical Contractor shall be responsible for final adjustment and testing of all devices.

3.02 TESTING

- A. Verify proper location and operation of all devices.
- B. Verify dimmers function without:
 - 1. Producing lamp flicker or audible noise.
 - 2. Interference of audio and visual equipment.
- C. Adjust occupancy sensors for a 20 minute time delay.
- D. Adjust occupancy sensor sensitivity such that movement outside range of coverage shall not trigger sensor.
- E. Adjust ambient light sensor to maintain illuminance level equal to light level from controlled lighting in the space when no daylight is present or as indicated per drawings. Demonstrate ambient light sensor(s) control lighting as specified.
- F. Functionality of all installed lighting controls shall be verified by Commissioning Agent as required in Florida Energy Conservation Code.

END OF SECTION

SECTION 26 2200
LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 0526 – Grounding and Bonding for Electrical Systems
- C. Section 26 0529 – Hangers and Supports for Electrical Systems
- D. Section 26 0533 – Raceway and Boxes for Electrical Systems
- E. Section 26 0553 – Electrical Systems Identification

1.02 DESCRIPTION

- A. Section includes dry type distribution and buck-boost transformers rated 600V and less, with capacities up to 300 kVA.

1.03 REFERENCE STANDARDS

- A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting
- B. IEE C57.12.91 – Test Code for Dry Type Distribution and Power Transformers
- C. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)
- D. NEMA ST 1 – Specialty Transformers (except General Purpose Type)
- E. NEMA ST 20 – Dry-Type Transformers for General Applications
- F. NFPA 70 – National Electrical Code
- G. UL 506 – Specialty Transformers
- H. UL 1561 – Dry-Type General Purpose and Power Transformers
- I. 10 CFR 431.196 (a) (2) – Energy Conservation Standards and Their Effective Dates

1.04 SUBMITTALS

- A. Product Data:
 - 1. Include rated nameplate data, capacities, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings:
 - 1. For each transformer size and type:
 - a. Physical dimensions, including bolting templates, weight, and center of gravity
 - b. Loads, method of field assembly, components, and location and size of each field connection
 - c. Wiring Diagrams: Power, signal, and control wiring
 - d. kVA rating
 - e. Primary taps
 - f. Insulation class and temperature rise
 - g. Efficiency values measured at 0, 25, 50, 75, and 100% load
 - h. Impedance value – X/R and %Z
 - i. Sound level
 - j. “K” factor listing, where applicable
- C. Manufacturer’s Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- D. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
- E. Output Settings Report: Record output voltages and tap settings.
- F. Closeout Submittals:
 - 1. Project Record Documents:

- a. Record actual locations of transformers.
2. Operation and Maintenance Data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

1.05 QUALITY ASSURANCE

- A. Obtain transformers from one source and by single manufacturer.
- B. Regulatory Requirements:
 1. Comply with NFPA 70 for components and installation.
 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.
- B. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.07 WARRANTY

- A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Schneider Square D
- B. ABB-GE Industrial Solutions
- C. Eaton Cutler-Hammer
- D. Siemens

2.02 DISTRIBUTION TRANSFORMERS

- A. Fabrication:
 1. NEMA ST 20, UL 1561
 2. Factory assembled and tested
 3. Air-cooled, for 60 Hz service
 4. Two winding dry type
 5. Coils:
 - a. Continuous wound construction and impregnated with non-hydroscopic, thermosetting varnish.
 - b. Conductors: Continuous windings without splices, except for taps, and encapsulated wire resin compound to seal out moisture and air.
 - c. Materials: Aluminum
 - d. Separate primary and secondary
 - e. Internal Connections: Braised or pressure type
 6. Cores: High-grade silicon steel, non-aging, with high magnetic permeability, low eddy current losses and low hysteresis. Magnetic flux densities below saturation point. Core laminations clamped with steel members, one leg per phase.
 7. Rubber vibration absorbing mounts to isolate base of enclosure from core and coil assembly.

8. Transformer neutral visibly grounded to enclosures with flexible grounding conductor.
- B. Enclosure:
 1. NEMA 250
 2. Type 2, unless otherwise indicated to comply with environmental conditions at installed location.
 3. Code-gauge steel panel over core and coil.
 4. Ventilated (air-cooled): Louvered openings for convection cooling.
 5. Cooling and terminal chamber access with both sides and rear obstructed.
 6. Manufacturer's lifting eyes or brackets.
 7. Finish: Manufacturer's standard gray enamel over prime coat after being degreased, cleaned, and phosphatized.
- C. Ratings:
 1. KVA Rating: 300 kVA maximum
 2. Primary Voltage: 480V, 3-phase, 3 wires.
 3. Secondary Voltage: 208Y/120V, 3-phase, 4 wires unless indicated otherwise on drawings.
 4. Insulation Class and Winding Temperature Rise:
 - a. All Transformers: Class 220°C, continuous operation at full load with temperature rise of not over 150°C above 40°C ambient temperature, with a maximum hot spot temperature of 220°C.
 5. Top of Enclosure Temperature: Maximum 35°C above 40°C ambient temperature at warmest point at full load.
 6. K-Factor Rating: UL 1561, as indicated.
- D. Primary Taps:
 1. Transformers rated 3kVA - 15kVA: One 5% above and one 5% below normal full capacity.
 2. Transformers rated 15kVA and larger: Two 2.5% above and two 2.5% below normal full capacity, minimum of four taps.
- E. Energy Efficiency:
 1. Transformers rated 15kVA and larger, except K-rated, quiet type and ultra quiet type:
 - a. 10 CFR 431.196 (a) (2) compliant
- F. Sound Levels:
 1. NEMA ST 20, maximum average sound levels as follows:
 - a. 45 dB for general-purpose transformer sizes less than 51kVA.
 - b. 50 dB for general-purpose transformer sizes 51-150kVA.
 - c. 55 dB for general-purpose transformer sizes 151-300kVA.
 2. Minimum of 3 dB less than NEMA ST 20. Maximum average sound levels as follows:
 - a. 42 dB for quiet type transformer sizes less than 51kVA.
 - b. 47 dB for quiet type transformer sizes 51-150kVA.
 - c. 52 dB for quiet type transformer sizes 151-300kVA.
 3. Maximum average sound levels, when factory tested according to IEEE C57.12.91, as follows:
 - a. 35 dB for ultra quiet transformers, for all sizes through 300kVA.
- G. Electrostatic Shielding, where indicated: Each winding with an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 1. Coil leads and terminal strips arranged to minimize capacitive coupling between input and output terminals.
 2. Special terminal included for grounding the shield.
 3. Shield Effectiveness:
 - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.

- b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
- c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

2.03 BUCK-BOOST TRANSFORMERS

- A. Description: NEMA ST 1, UL 506, UL 1561, same as distribution transformers, except rated for continuous duty and with wiring terminals suitable for connection as autotransformer.
- B. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Finish Color: Gray enamel over prime coat.

2.04 LUGS

- A. Manufacturer's primary and secondary bolted lugs: labeled for 75°C copper and aluminum conductors for ventilated enclosures.
- B. Connections at sides near bottom, accessible from front of cabinet.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions for compliance with enclosure and ambient temperature requirements for each transformer.
- B. Examine areas and surface to receive transformers for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Verify space indicated for transformers' mounting meets code-required working clearances.
- D. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.
- E. Verify that ground connections are in place and requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems have been met.
- F. Verify with manufacturer that "touch-up" paint kit is available for repainting.

3.02 INSTALLATION

- A. Install transformers in accordance with ANSI/NECA 1.
- B. Install level and plumb within 1/2 degree, and at least 6" from the adjacent wall or structure to insure proper ventilation, in accordance with manufacturer's written instruction, and in compliance with recognized industry practices.
- C. Transformer mounting and vibration control:
 - 1. Mount transformers on floor.
 - 2. Floor mounting:
 - a. Secure to floor via isolation pads between floor brackets (per manufacturer recommendations) and transformer.
 - b. Mount on spring isolator.
 - 3. Wall mounting:
 - a. Secure to concrete-and-block wall via isolation pads between wall brackets (fabricated by manufacturer) and transformer.
 - b. Secure to gypsum walls with independent steel slotted channel supports, secured to floor via isolation pads between wall brackets (fabricated by manufacturer) and transformer.
 - c. Mount on spring isolator.
 - 4. Suspended mounting:
 - a. Suspend transformer enclosures designed for floor mounting, where suspended from structural ceiling, via trapeze constructed of steel slotted channel support system hung via 3/8" minimum steel threaded hanger rods attached to structural members or inserts

in structural slab. Each rod to contain spring isolator ceiling hanger. Use locking type nuts in assembly.

- b. Install restraint cables sway bracing sized to resist a horizontal force of 162% of the operating weight acting in any direction for normal power transformers and 212% of the operating weight for emergency/standby power transformers.
- c. Anchor and fasten transformers and their supports to building structural elements by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
- D. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to transformer using small, corrosion-resistant metal screws or rivets. Do not use contact adhesive.
 - 1. Indicate kVA rating, voltage/phase rating, taps, insulation class and temperature rise, impedance value, sound level, and K-factor listing.
- E. Install conduit per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.
- F. Install transformer in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

3.03 CONNECTIONS

- A. Ground transformers according to Section 26 0526 – Grounding and Bonding for Electrical Systems.
- B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.04 FIELD QUALITY CONTROL

- A. Inspect transformers for physical damage, proper alignment, anchorage, grounding, connections, and installation.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings and submit to Engineer.

3.05 REPAINTING

- A. Remove paint splatters and other marks from surface of equipment.
- B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.06 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 h of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10% and not being lower than nameplate voltage minus 3% at maximum load conditions.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5%, at secondary terminals.

3.07 CLEANING

- A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 2416.13
LIGHTING AND APPLIANCE PANELBOARDS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 0526 – Grounding and Bonding for Electrical Systems
- C. Section 26 0529 – Hangers and Supports for Electrical Systems
- D. Section 26 0533 – Raceway and Boxes for Electrical Systems
- E. Section 26 0553 – Electrical Systems Identification
- F. Section 26 0573 – Power System Studies
- G. Section 26 2713 – Electrical Metering

1.02 DESCRIPTION

- A. Section includes circuit breaker type lighting and appliance branch circuit panelboards as shown on drawings and as scheduled.

1.03 REFERENCE STANDARDS

- A. NECA 407 - Recommended Practice for Installing and Maintaining Panelboards
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- C. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
- D. NEMA PB 1 - Panelboards
- E. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less
- F. NFPA 70 - National Electrical Code
- G. UL 50 - Enclosures for Electrical Equipment
- H. UL 67 - Panelboards
- I. UL 486A-486B - Wire Connectors
- J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
- K. UL 869A - Reference Standard for Service Equipment

1.04 SUBMITTALS

- A. Product Data:
 - 1. Submit catalog data showing specified features of standard products. Eliminate extraneous catalog data.
- B. Shop Drawings:
 - 1. Submit for review prior to manufacture. Include complete description, front view, dimensions, voltage, main bus ampacity, circuit breaker arrangement and sizes, short circuit current rating, and factory settings of individual protective devices.
 - 2. Submit 1/4" scale electrical room floor plans with panelboard locations.
- C. Partial Submittals:
 - 1. Panelboards shall be submitted for review together. Partial submittals of panelboards are not acceptable and will be rejected.
- D. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Test Reports:
 - 1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

- F. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual locations of panelboards and record actual circuiting arrangements.
 - 2. Operation and Maintenance Data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
 - b. Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - c. Include time-current curves and selectable ranges for each type of overcurrent protective device.
 - d. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.05 QUALITY ASSURANCE

- A. Obtain panelboards, overcurrent protective devices, components, and accessories from one source and by single manufacturer.
- B. Regulatory Requirements:
 - 1. Comply with NFPA 70.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.
- B. Comply with NEMA PB 1.1 and manufacturer's written instructions.

1.07 WARRANTY

- A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.08 MAINTENANCE

- A. Extra Materials:
 - 1. Furnish Owner with two keys per panelboard.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Schneider Square D
- B. ABB-GE Industrial Solutions
- C. Eaton Cutler Hammer
- D. Siemens

2.02 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

- A. NEMA PB 1, UL 67
- B. Fabrication:
 - 1. Factory assembled.
 - 2. With door
 - 3. Incoming feeder lugs: copper conductors.
 - 4. Multiple lugs to match number of conductors per phase.
 - 5. Sub-feed (double) lugs, or feed-through lugs where indicated.
 - 6. Filler plates.

7. Wiring terminals for field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.
- C. Panelboard Buses:
1. Copper
 2. Ampere rating as scheduled
 3. Ground bus: uninsulated, bonded to panelboard cabinet
 4. Insulated neutral bus: 100% of phase bus rating
- D. Molded-Case Circuit Breakers:
1. NEMA AB 1, UL 489
 2. Bolt-on type, labeled for 75°C copper and aluminum conductors
 3. Quick-make, quick-break, with thermal-magnetic trip.
 4. Common internal trip on multi-pole breakers. Handle-ties are not permitted.
 5. Ampere rating as scheduled
 6. Listed as Type SWD for lighting circuits
 7. Listed as Type HACR for air conditioning equipment circuits
 8. Bussing, device mounting hardware, and steel knockouts in dead front where "space" is indicated
 9. Tandem circuit breakers are not acceptable
 10. Locks on trip handles where indicated
 11. Ground fault equipment protection (GFEP), rated 30 mA trip, to provide equipment protection for branch circuits feeding electrical heat tracing, where indicated
 12. Ground fault circuit interrupter (GFCI), rated at 4-6 mA trip for protection of personnel, where indicated
- E. Cabinet
1. NEMA 250, UL 50
 2. NEMA Type 1, Type 3R (outdoor locations) enclosure.
 3. Front (trim) flush or surface mounted with door in front with concealed self-adjusting trim clamps, and complete with cylinder-type lock and catch.
 4. Same height matching trim, where two cabinets are mounted adjacent to one another in finished areas.
 5. All sections of panelboards have the same size, where oversize cabinets are required for one section of multi-section panelboard.
 6. Boxes and fronts made of code-gauge galvanized steel.
 7. Manufacturer's standard gray enamel finish over prime coat.

2.03 METERS

- A. Provide separate metering compartments with digital meter in accordance with Section 26 2713 - Electrical Metering.

2.04 SERVICE ENTRANCE

- A. UL 869A
- B. Panelboards labeled as suitable for use as service entrance equipment where applicable and must include connection for bonding and grounding of neutral conductor.
- C. Barriers shall be placed such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations.

2.05 SHORT CIRCUIT CURRENT RATING

- A. Each panelboard with minimum short circuit current rating as indicated on drawings.
- B. Panelboards marked with their maximum short circuit current rating at supply voltage.
- C. Panelboards: Fully rated. Series-rated panelboards are not acceptable.

2.06 SURGE PROTECTIVE DEVICES (SPD)

- A. By panelboard manufacturer.
- B. Per requirements in Section 26 4300 – Surge Protective Devices.

2.07 SPARE CONDUITS

- A. Spare conduits per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

PART 3 - EXECUTION

3.01 COORDINATION WITH MANUFACTURER

- A. Instruct manufacturer about the location of additional wiring gutter space when required (i.e., top, bottom, right, left, or combination).
- B. Instruct manufacturer about the location of main lugs or main circuit breaker (i.e., top or bottom feed based on incoming feeder entrance location).
- C. Instruct manufacturer to provide multiple lugs where conductors in parallel or sub-feed (double) lugs or feed-through lugs are indicated.
- D. Instruct manufacturer on the size of cross-connection cables for panelboards fed via sub-feed (double) lugs or feed-through lugs. Make cable size with ampacity equal to incoming feeder.
- E. Verify that “touch-up” paint kit is available for repainting.

3.02 EXAMINATION

- A. Verify that space indicated for panelboard mounting meets code-required working clearances and dedicated equipment space.
- B. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.03 INSTALLATION

- A. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- B. Install panelboards plumb and rigid without distortion of box, in accordance with manufacturer's written instructions, and in compliance with recognized industry practices.
- C. Panelboard mounting:
 - 1. Fasten panelboards firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
 - 2. Anchor and fasten panelboards and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
 - 3. Install two rows of steel slotted channel, with a minimum of 4 attachment points, for each panelboard section.
 - 4. When not located directly on wall, provide support frame of steel slotted channel anchored to floor and ceiling structure.
- D. Install top breaker handle a maximum of 6'-7" above finished floor or working platform with handle in its highest position.
- E. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A – 486B.
- F. Install as-built typewritten circuit directory in directory frame (to indicate installed circuit loads) mounted inside each panelboard door. Include description of connected loads, room number, room name, area, or item served for each branch circuit. Indicate motor names and horsepower as applicable. Cover circuit directory with colorless plastic. Coordinate with Owner and Architect to ensure that room numbers used in panel directory are final numbers assigned by Owner.
- G. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each panelboard using small metal screws, rivets, or contact adhesive.

1. Include panelboard name, amperage, voltage, phase, and number of wires.
- H. Label spare circuits as SPARE. Leave spare breakers in OFF position.
- I. Room numbers used shall be those used by Owner except as otherwise directed by Architect.
- J. Install panelboard in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.
- K. Install filler plates in unused spaces.
- L. Install three 3/4" spare conduits stubbed into accessible ceiling space or space designated to be ceiling space in the future for all flush-mounted panelboards. Install conduits in accordance with requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.
- M. Install three 3/4" spare conduits stubbed into ceiling space above and below for panelboards that serve loads on levels other than that where the panelboard is located. Install conduits in accordance with requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

3.04 CONNECTIONS

- A. Ground panelboards according to Section 26 0526 – Grounding and Bonding for Electrical Systems.
- B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.05 FIELD QUALITY CONTROL

- A. Inspect for physical damage, proper alignment, anchorage, and grounding.
- B. Maintain proper phasing for multi-wire circuits.
- C. **[Check phase-to-phase and phase-to-ground insulation resistance levels prior to energization of panelboards.]**
- D. **[Check panelboards for electrical continuity of circuits and for short-circuits prior to energization.]**

3.06 REPAINTING

- A. Remove paint splatters or other marks from surface of panelboards.
- B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.07 ADJUSTING

- A. Adjust fronts, covers, hinges, and locks.

3.08 CLEANING

- A. Clean panelboard interiors and exteriors prior to final inspection. Remove paint splatters and other spots, dirt and debris.

END OF SECTION

SECTION 26 2416.16
DISTRIBUTION PANELBOARDS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 0526 – Grounding and Bonding for Electrical Systems
- C. Section 26 0529 – Hangers and Supports for Electrical Systems
- D. Section 26 0553 – Electrical Systems Identification
- E. Section 26 0573 – Power System Studies
- F. Section 26 2713 – Electrical Metering
- G. Section 26 4300 – Surge Protective Devices

1.02 DESCRIPTION

- A. Section includes circuit breaker type power distribution panelboards as shown on drawings and as scheduled.

1.03 REFERENCE STANDARDS

- A. NECA 407 - Recommended Practice for Installing and Maintaining Panelboards
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- C. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
- D. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- E. NEMA PB 1 - Panelboards
- F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less
- G. NFPA 70 - National Electrical Code
- H. UL 50 - Enclosures for Electrical Equipment
- I. UL 67 - Panelboards
- J. UL 486A – 486B - Wire Connectors
- K. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
- L. UL 869A - Reference Standard for Service Equipment

1.04 SUBMITTALS

- A. Product Data:
 - 1. Submit catalog data showing specified features of standard products. Eliminate extraneous catalog data.
- B. Shop Drawings:
 - 1. Submit for review prior to manufacture. Include complete description, front view, dimensions, voltage, main bus ampacity, circuit breaker arrangement and sizes, short circuit current rating, and factory settings of individual protective devices.
 - 2. Submit 1/4" scale electrical room floor plans with panelboard locations.
- C. Partial Submittals:
 - 1. Panelboards shall be submitted for review together. Partial submittals of panelboards are not acceptable and will be rejected.
- D. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Test Report:

1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
- F. Closeout Submittals:
1. Project Record Documents:
 - a. Record actual locations of panelboards and record actual circuiting arrangements.
 2. Operation and Maintenance Data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
 - b. Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - c. Include time-current curves and selectable ranges for each type of overcurrent protective device.
 - d. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.05 QUALITY ASSURANCE

- A. Obtain panelboards, overcurrent protective devices, components, and accessories from one source and by a single manufacturer.
- B. Regulatory Requirements:
 1. Comply with NFPA 70.
 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.
- B. Comply with NEMA PB 1.1 and manufacturer's written instructions.

1.07 WARRANTY

- A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.08 MAINTENANCE

- A. Extra Materials:
 1. Furnish Owner with two keys per panelboard.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Schneider Square D
- B. ABB-GE Industrial Solutions
- C. Eaton Cutler Hammer
- D. Siemens

2.02 POWER DISTRIBUTION PANELBOARDS

- A. NEMA PB 1, UL 67.
- B. Fabrication:
 1. Factory assembled
 2. Individualized breaker dead-front cover without door
 3. Incoming feeder lugs: copper conductors
 4. Multiple lugs to match number of conductors per phase
 5. Sub-feed (double) lugs, or feed-through lugs where indicated

6. Filler plates
 7. Wiring terminals for field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.
 8. Barriers shall be placed such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations.
- C. Panelboard Buses:
1. Copper
 2. Ampere rating as scheduled
 3. Ground bus: uninsulated, bonded to panelboard cabinet
 4. Insulated neutral bus where applicable: 100% of phase bus rating
- D. Molded-Case Circuit Breakers:
1. NEMA AB 1, UL 489
 2. Bolt-on or I-line type, labeled for 75°C copper and aluminum conductors
 3. Quick-make, quick-break, with thermal-magnetic trip and electronic (solid-state microprocessor-based) trip.
 4. Equipped with individually insulated, braced, and protected connectors
 5. Common internal trip on multi-pole breakers. Handle-ties are not permitted.
 6. Ampere rating as scheduled
 7. Front face flush with each other
 8. Large, permanent, individual circuit numbers affixed to each breaker in uniform position
 9. Tripped indication clearly shown by breaker handle taking position between "ON" and "OFF."
 10. Listed as Type HACR for air conditioning equipment circuits
 11. Bussing, device mounting hardware, and steel knockouts in dead front where "space" is indicated
 12. For 225A frame size and below: thermal-magnetic trip
 13. For 250A frame size and above: electronic trip units interchangeable in the field within the frame size and field-adjustable long time pick-up, long time delay, short time pick-up, short time delay, and instantaneous current settings. Each adjustment shall have discrete settings and shall be independent of all other adjustments.
- E. Cabinet
1. NEMA 250, UL 50
 2. NEMA Type 1, Type 3R (outdoor locations) enclosure.
 3. Four-piece front (trim) surface mounted without door with breakers exposed.
 4. Same height matching trim, where two cabinets are mounted adjacent to one another in finished areas.
 5. All sections of panelboards have the same size, where oversize cabinets are required for one section of multi-section panelboard.
 6. Boxes and fronts made of code-gauge galvanized steel
 7. Manufacturer's standard gray enamel finish over prime coat.

1.1 METERS

- A. Provide separate metering compartments with digital meter in accordance with Section 26 2713 - Electrical Metering.

2.03 SERVICE ENTRANCE

- A. UL 869A
- B. Panelboards labeled as suitable for use as service entrance equipment where applicable and must include connection for bonding and grounding of neutral conductor.

2.04 SHORT CIRCUIT CURRENT RATING

- A. Each panelboard with minimum short circuit current rating as indicated on drawings.
- B. Panelboards marked with their maximum short circuit current rating at supply voltage.
- C. Panelboards: Fully rated. Series-rated panelboards are not acceptable.

2.05 SURGE PROTECTIVE DEVICES (SPD)

- A. By panelboard manufacturer.
- B. Per requirements in Section 26 4300 – Surge Protective Devices.

PART 3 - EXECUTION

3.01 COORDINATION WITH MANUFACTURER

- A. Instruct manufacturer about the location of additional wiring gutter space when required, i.e. top, bottom, right, left, or combination.
- B. Instruct manufacturer about the location of main lugs or main circuit breaker (i.e., top or bottom feed based on incoming feeder entrance location).
- C. Instruct manufacturer to provide multiple lugs where conductors in parallel or sub-feed (double) lugs or feed-through lugs are indicated.
- D. Instruct manufacturer on the size of cross-connection cables for panelboards fed via sub-feed (double) lugs or feed-through lugs. Make cable size with ampacity equal to incoming feeder.
- E. Verify that “touch-up” paint kit is available for repainting.

3.02 EXAMINATION

- A. Verify that space indicated for panelboard mounting meets code-required working clearances and dedicated equipment space.
- B. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.03 INSTALLATION

- A. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- B. Install panelboards plumb and rigid without distortion of box, in accordance with manufacturer's written instructions, and in compliance with recognized industry practices.
- C. Panelboard mounting:
 - 1. Fasten panelboards firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
 - 2. Anchor and fasten panelboards and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
 - 3. Install two rows of steel slotted channel, with a minimum of four attachment points, for each panelboard section.
 - 4. When not located directly on wall, provide support frame of steel slotted channel anchored to floor and ceiling structure.
- D. Install top breaker handle a maximum of 6'-7" above finished floor or working platform, with handle in its highest position.
- E. Tighten electrical connectors and terminals according to equipment manufacturer's published torque tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A –486B.
- F. Install as-built typewritten circuit directory in directory frame (to indicate installed circuit loads before completing load balancing) affixed to outside cover of each panelboard. Include description of connected loads, room number, room name, area, or item served for each branch circuit. Indicate motor names and horsepower as applicable. Cover circuit directory with colorless plastic.
- G. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each panelboard using small, corrosion-resistant metal screws or rivets. Do not use contact adhesive.

1. Indicate panelboard name, amperage, voltage, phase, and number of wires.
- H. Label spare circuits as SPARE. Leave spare breakers in OFF position.
- I. Room numbers used shall be those used by Owner except as otherwise directed by Architect.
- J. Install panelboard in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.
- K. Install filler plates in unused spaces.

3.04 CONNECTIONS

- A. Ground panelboards according to Section 26 0526 – Grounding and Bonding for Electrical Systems.
- B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.05 FIELD QUALITY CONTROL

- A. Inspect for physical damage, proper alignment, anchorage, and grounding.

3.06 REPAINTING

- A. Remove paint splatters or other marks from surface of panelboards.
- B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint to Owner.

3.07 ADJUSTING

- A. Adjust fronts, covers, hinges, and locks.
- B. Circuit Breakers: Set field-adjustable trip settings or change the trip settings recommended by the overcurrent protective device coordination study per Section 26 0573 – Power System Studies.

3.08 CLEANING

- A. Clean panelboard interiors and exteriors prior to final inspection. Remove paint splatters and other spots, dirt and debris.

END OF SECTION

**SECTION 26 2726
WIRING DEVICES**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems
- B. Section 26 0553 - Electrical Systems Identification

1.02 DESCRIPTION

- A. Section includes general-use snap switches, receptacles, pendant cord-connector devices, cord and plug sets and device cover plates.

1.03 REFERENCE STANDARDS

- A. IEEE C62.41.2 – Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits
- B. IEEE C62.45 – Surge Testing for Equipment Connected to Low-Voltage (1000V and less) AC Power Circuits
- C. NECA 1 – Good Workmanship in Electrical Contracting
- D. NFPA 70 – National Electrical Code
- E. NEMA WD-1 – General Color Requirements for Wiring Devices
- F. NEMA WD-6 – Wiring Devices - Dimensional Requirements
- G. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)
- H. UL 20 – General-Use Snap Switches
- I. UL 498 – Attachment Plugs and Receptacles
- J. UL 943 – Ground-Fault Circuit-Interrupters
- K. UL 1203 – Safety Explosion-Proof and Dust-Ignition Proof Electrical Equipment for Use in
- L. UL 1436 – Outlet Circuit Testers and Similar Indicating Devices
- M. UL 1449 – Transient Voltage Surge Suppressors

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
- F. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual locations and ratings of wiring devices.
 - 2. Operation and Maintenance Data:
 - a. Include in manufacturers' packing label warnings and instruction manuals with labeling conditions.
 - b. Include source and current prices of replacement parts and supplies.

1.05 QUALITY ASSURANCE

- A. Obtain wiring devices from one source and by single manufacturer.
- B. Regulatory Requirements:
 - 1. Comply with NFPA 70 for components and installation.

2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

1.07 WARRANTY

- A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Cooper Wiring Devices; a division of Cooper Industries, Inc.
- B. Hubbell Incorporated; Wiring Device-Kellems
- C. Leviton Manufacturing Company, Inc.
- D. Pass & Seymour/Legrand; Wiring Devices & Accessories

2.02 GENERAL-USE SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches: Heavy-duty (specification grade); back and side wired; flush or surface mounting; Body and Handle: thermoplastic with toggle handle; for connection to copper or copper-clad conductors:
 1. Ratings:
 - a. Voltage: 120-277V, AC
 - b. Current: 20 A
 2. Single pole
 3. Pendant and Through-cord: For field installation on flexible cord and provided with one "ON" and one "OFF" position.
 4. Switches for Connections to Aluminum Conductors: Comply with UL 1567.
 5. Weatherproof: Toggle switch

2.03 RECEPTACLES

- A. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
- B. Receptacles: 125 V, 20A, heavy-duty (specification grade); back and side wired; flush or surface mounted; straight blade; 2 pole, 3 wire grounding; thermoplastic body; duplex and single as indicated on drawings.
 1. Ground Fault Circuit Interrupter (GFCI):
 - a. Additional compliance with UL 943 Class A.
 - b. Leakage current trip level: 4 to 6 mA.
 - c. Trip time: .025 seconds nominal.
 - d. Non-feed through type
 - e. Reverse line-load function to prevent GFCI from functioning if wired incorrectly.
 - f. Indicator Light: Lighted when device is tripped.
 2. Transient Voltage Surge Suppression (TVSS):
 - a. Additional compliance with UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.
 - b. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.

- c. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
- 3. Tamper Resistant (TR):
 - a. Requires insertion of object in both left and right contacts to energize.
 - b. 2- or 3-prong plug.
- 4. Twist-locking:
 - a. NEMA WD 6 configuration L5-20R unless indicated otherwise on drawings.
- 5. Switched: Upper half switched and lower half not switched.
- 6. Dedicated: Labeled "Dedicated."
- 7. Special Purpose Receptacles: Specification grade, rated for voltage, amperage and NEMA configuration as noted on drawings.

2.04 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configuration L5-20P and L5-20R, heavy-duty grade.
 - 1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 - 2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.05 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 1. Cord: Thermoset-insulated, stranded-copper conductors, with Type SOOW jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30%.
 - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.06 DEVICE COVER PLATES

- A. Single and combination types to match corresponding wiring devices:
 - 1. Attachment: Metal screws with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.035" thick, satin-finished stainless steel.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Thermoplastic with while-in-use hinged cover, and listed and labeled for use in "wet locations".
- B. Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, thermoplastic with weatherproof while-in-use hinged cover.
- C. Lockable Cover:
 - 1. Hinged steel cover with cylinder lock.
 - 2. Keyed all the same.
- D. Tamper Resistant (TR):
 - 1. Slide cover over receptacle.

2.07 FINISHES

- A. Color:
 - 1. Switch handles: White, except as follows:
 - a. Switch handles and receptacle faceplates connected to Emergency or Standby Power System: Red; labeled "Emergency."

PART 3 - EXECUTION

3.01 COORDINATION

- A. Special Purpose Receptacles: Coordinate final selections of NEMA configuration (locking, straight, blade, etc.) with configuration of plug on utilization equipment.
- B. Receptacles for Owner-furnished equipment and equipment furnished under other divisions of specifications: Match plug configurations.
- C. Cord and Plug Sets: Match equipment requirements.
- D. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers guided by riding against outside of the boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the device cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, excluding painting, is complete. Install device cover plates after painting is complete.

3.02 EXAMINATION

- A. Verify location of wiring devices with architectural interior elevation drawings, prior to rough-in.
- B. Verify outlet boxes are installed at proper height.
- C. Verify wall openings are neatly cut and completely covered by wall plates.
- D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.03 PREPARATION

- A. Clean debris from outlet boxes.

3.04 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise scheduled or indicated on drawings. Indicated dimensions are to center of device.
- B. Conductors:
 - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. Length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Do not place bare stranded conductors directly under device screws. Use crimp on fork terminals for device terminations.
- C. Device Installation:
 - 1. Replace all devices that have been in temporary use during construction or show signs of installation prior to completion of building finishing operations.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6" in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 - 7. When conductors larger than #12 AWG are installed on 15A or 20A circuits, splice #12 AWG pigtails for device connections.

8. Tighten unused terminal screws on the device.
 9. When mounting into metal boxes, remove fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
 10. Install devices plumb, level with finished surfaces and free from blemishes.
 11. Install lighting switches vertically on latch side of door within 6" of frame edge.
 12. Install devices above counters, 2" to the bottom of device above countertop or backsplash. Install all devices at same height above any one counter or fixed cabinet.
 13. Install special purpose receptacles and switches according to shop and rough-in drawings furnished by trade(s) producing such equipment. Verify locations prior to rough-in.
 14. Install weatherproof GFCI receptacles:
 - a. Within 25'-0" of roof-mounted mechanical equipment
 - b. Outdoors
 - c. As indicated on drawings
 15. Group adjacent switches under single, multigang wall plates.
 16. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor. Ground per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.
- D. Installation Orientations:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
 2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.
 3. Install switches with handle operating vertically, with "ON" position up.
 4. Unless otherwise indicated or where space problem occurs, mount devices flush, with long dimension vertical.
- E. Device Cover Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- F. Wall-Box Dimmers:
1. Install dimmers within terms of their listing.
 2. Verify that dimmers used for fan speed control are listed for that application.
 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- G. Arrangement of Devices:
1. Unless otherwise indicated or where space problem occurs, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.05 IDENTIFICATION

- A. Comply with Section 26 0553 – Electrical Systems Identification.
1. Switches and Receptacles: Use hot, stamped or engraved machine printing with black-filled lettering on face of cover plate, and durable wire markers or tags inside outlet boxes.
 - a. Receptacles: Label shall indicate receptacle voltage, phase, and amperage for receptacles other than 20A, 120 V, at top of cover plate, and panel and circuit number at bottom of cover plate.
 - b. Switches: Label shall indicate switch voltage, phase, and amperage at top of cover plate, and panel, circuit number and switch designation at bottom of cover plate.

3.06 FIELD QUALITY CONTROL

- A. Inspect wiring devices for defects.
- B. Operate wall switches with circuits energized and verify proper operation.

- C. Verify receptacle device is energized.
- D. Perform tests and prepare test reports:
 - 1. Test receptacle devices for proper polarity:
 - a. Test every receptacle with receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open. Rewire receptacles with faults and retest.
 - 2. Test each GFCI receptacle device for proper operation:
 - a. Perform testing using an instrument specifically designed and manufactured for testing ground-fault circuit interrupters. Apply the test to the receptacle. "TEST" button operation will not be acceptable as a substitute for this test. Replace receptacles that do not shut off power with 5/1000 A within 1/40 second and retest.
 - 3. Test Instruments: Use instruments that comply with UL 1436.
 - 4. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- E. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 V to 132 V.
 - 2. Percent Voltage Drop under 15A Load: A value of 5% or higher is not acceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- F. Operational Tests: Demonstrate the operation of each switch with the systems fully energized and operating. Each switch shall be demonstrated three times.

3.07 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.08 CLEANING

- A. Remove excess plaster from interior of outlet boxes.
- B. Clean devices and cover plates after painting is complete. Replace stained or improperly painted devices and cover plates.

END OF SECTION

**SECTION 26 2813
FUSES**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0573 - Power System Studies
- B. Section 26 2816 - Enclosed Switches and Circuit Breakers
- C. Section 26 2913 - Enclosed Controllers

1.02 DESCRIPTION

- A. Section includes nonrenewable cartridge fuses, rated 600V and less, for use in low-voltage power distribution system and spare fuse cabinet.

1.03 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses
- B. UL 248-1 - Low Voltage Fuses - Part 1: General Requirements
- C. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses
- D. UL 512 - Fuseholders

1.04 SUBMITTALS

- A. Product Data:
 - 1. Submit the following for each fuse type and size indicated:
 - a. Manufacturer's technical data on features, performance, electrical characteristics, ratings, and dimensions.
 - b. Time-current curves, coordination charts and tables, and related data.
 - c. Let-through current curves for fuses with current-limiting characteristics.
 - d. Fuse size for each elevator disconnect switch.
- B. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual class, size, and location of fuses.

1.05 QUALITY ASSURANCE

- A. Obtain fuses from one source and by single manufacturer.
- B. Comply with NFPA 70 for components and installation.

1.06 MAINTENANCE

- A. Extra Materials:
 - 1. Furnish to the Owner a quantity of spare fuses equal to 10% of the total quantity of each fuse class and size installed, minimum of 3 of each fuse class and size.
 - 2. Furnish 2 fuse pullers for each size fuse.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Cooper Bussmann
- B. Mersen
- C. Littelfuse
- D. Edison Fusegear

2.02 CARTRIDGE FUSES

- A. NEMA FU 1, UL 248-1.
- B. Characteristics: nonrenewable current-limiting cartridge fuse; current rating and class, as specified or indicated, and voltage rating consistent with circuit voltage.
- C. Miscellaneous data:

UL Standard	Class	Volts	Amperage	Interrupting Rating (Amp RMS Sym.)
248-12	RK5	250 or 600	0-600	200,000

2.03 FUSEBLOCKS

- A. UL 512
- B. Thermoplastic base with UL flammability 94VO
- C. Clip reinforcing springs – 100A and above
- D. 200,000 A RMS Sym withstand rating
- E. Copper or aluminum connections

2.04 TOUCH SAFE FUSEHOLDERS

- A. UL 512
- B. Thermoplastic base with UL flammability 94VO
- C. Cover over fuses
- D. Neon indicator lamp: "ON" when fuse opens

2.05 SPARE FUSE CABINET

- A. Wall-mounted sheet metal cabinet with shelves, suitably sized to store spare fuses and fuse pullers specified with 10% capacity minimum.
- B. Doors shall be hinged, with hasp for Owner's padlock.
- C. Finish shall be gray enamel.
- D. Cabinet shall have nameplate engraved "Spare Fuses" in 1/2" letters on door.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

3.02 INSTALLATION

- A. Verify proper fuse locations, sizes, and characteristics.
- B. Install fuses in fusible devices 26 2816 – Enclosed Switches and Circuit Breakers and 26 2913 – Enclosed Controllers at job site.
- C. Arrange fuses so manufacturer, class, and size are readable without removing fuse.
- D. Install typewritten labels on inside door of each fused device, indicating fuse replacement information.
- E. Install spare fuse cabinet.

3.03 APPLICATION

- A. Motor Branch Circuits: Class RK5.
- B. Other Branch Circuits: Class RK5.

3.04 CLEANING

- A. Clean fuses and tighten connections prior to energizing of equipment.

END OF SECTION

SECTION 26 2816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 0526 – Grounding and Bonding for Electrical Systems
- C. Section 26 0529 – Hangers and Supports for Electrical Systems
- D. Section 26 0553 – Electrical Systems Identification
- E. Section 26 0573 – Power System Studies
- F. Section 26 2813 – Fuses

1.02 DESCRIPTION

- A. Section includes fusible and non-fusible disconnect switches and circuit breakers in individual enclosures.

1.03 REFERENCE STANDARDS

- A. ANSI//NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting
- B. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures
- C. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- D. NFPA 70 - National Electrical Code
- E. UL 98 - Enclosed and Dead Front Switches
- F. UL 486A - 468B - Wire Connectors
- G. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
- H. UL 869A - Reference Standard for Service Equipment

1.04 SUBMITTALS

- A. Product Data:
 - 1. Submit catalog cut sheet indicating voltage, amperage, HP ratings, enclosure type, and dimension, fuse clip features, terminal lugs and all accessories including interlock devices, short circuit current ampere rating and factory settings of individual protective devices.
- B. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- C. Test Reports:
 - 1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
- D. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual locations of disconnect switches and ratings of installed fuses.
 - b. Record actual locations and continuous current ratings of enclosed circuit breakers.
 - 2. Operation and Maintenance Data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
 - b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.05 QUALITY ASSURANCE

- A. Obtain disconnect switches and enclosed circuit breakers from one source and by single manufacturer.
- B. Regulatory Requirements:
 - 1. Comply with NFPA 70 for components and installation.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.
- B. Comply with manufacturer's written instructions.

1.07 WARRANTY

- A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Schneider Square D
- B. ABB-GE Industrial Solutions
- C. Eaton Cutler-Hammer
- D. Siemens

2.02 DISCONNECT SWITCHES

- A. NEMA KS 1, UL 98
- B. Load interrupter enclosed knife switch, heavy-duty type.
- C. Fusible or non-fusible type as indicated.
- D. Switch Interiors:
 - 1. Switch blades that are visible in "OFF" position when switch door is open.
 - 2. Plated current carrying parts.
 - 3. Removable arc suppressors to permit easy access to line side lugs.
- E. Switch Mechanism:
 - 1. Quick-make, quick-break, with visible blades and externally operable handle.
 - 2. Lockable only in "OFF" position and accept three industrial type, heavy-duty padlocks.
 - 3. Dual cover interlock to prevent unauthorized opening of switch door when handle is in "ON" position, and to prevent closing of switch mechanism with door open.
 - 4. Defeater mechanism to bypass interlock.
 - 5. Operating handle integral part of enclosure.
 - 6. Handle to physically indicate "ON" and "OFF" position.
- F. Ratings:
 - 1. Ampacity as indicated on drawings.
 - 2. Horsepower rated.
- G. Fusible Switches:
 - 1. Rejection clips for Class R fuses specified.
 - 2. Fuses: Per requirements in Section 26 2813 – Fuses.

2.03 ENCLOSED CIRCUIT BREAKERS

- A. NEMA AB 1, UL 489.
- B. Enclosed molded-case circuit breakers:

1. Tripped indication clearly shown on breaker handle taking position between “ON” and “OFF”.
 2. 225A frame size and below: thermal-magnetic trip.
 3. 250A frame size and above: electronic (solid-state microprocessor-based) trip units interchangeable in the field within the frame size and field-adjustable long time pick-up, long time delay, short time pick-up, short time delay, and instantaneous current settings. Each adjustment shall have discrete settings and shall be independent of other adjustments.
 4. Locks on trip handles where indicated.
 5. Shunt trip, where indicated.
- C. Breaker Mechanism:
1. Quick-make, quick-break.
- D. Ratings:
1. Ampacity as indicated on drawings.
 2. Listed as Type HACR for air conditioning equipment circuits.
 3. Listed as Type SWD for lighting circuits.

2.04 LUGS

- A. Front removable lugs.
- B. Labeled for 75°C copper and aluminum conductors.
- C. Multiple lugs to match number of conductors per phase.
- D. Termination of field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

2.05 ACCESSORIES:

- A. Solid neutral assembly, where required.
- B. Equipment ground kit.
- C. One set of normally open (NO) auxiliary contacts, where disconnect switch is installed at a remote motor served by variable frequency drive (VFD).

2.06 ENCLOSURES

- A. NEMA KS 1, NEMA AB 1, UL 98, UL 489, as applicable.
- B. NEMA Type 1, Type 3R (outdoor locations) enclosure.
- C. Code-gauge galvanized steel.
- D. Manufacturer’s standard gray enamel finish over prime coat.
- E. Surface-mounted.

2.07 SERVICE ENTRANCE

- A. UL 869A
- B. Switches and circuit breakers identified for use as service entrance equipment are to be labeled for this application, provided with solid neutral assembly and equipment ground bar, and must include connection for bonding and grounding of neutral conductor.

2.08 SHORT CIRCUIT CURRENT RATING

- A. Each circuit breaker shall have minimum short circuit current rating as indicated on drawings.

PART 3 - EXECUTION

3.01 COORDINATION WITH MANUFACTURER

- A. Instruct manufacturer about the location of incoming lugs, i.e., top or bottom feed based on incoming feeder entrance location.
- B. Verify that “touch-up” paint kit is available for repainting.

3.02 EXAMINATION

- A. Examine areas and surface to receive disconnect switches and enclosed circuit breakers for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Verify that space indicated for disconnect switches and enclosed circuit breakers mounting meets code-required working clearances.
- C. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.03 INSTALLATION

- A. Install disconnect switches and/or enclosed circuit breakers in accordance with ANSI/NECA 1.
- B. Install disconnect switches and/or enclosed circuit breakers level and plumb, in accordance with manufacturer's written instruction.
- C. Disconnect switches and enclosed circuit breakers mounting:
 - 1. Fasten disconnect switches and enclosed circuit breakers firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
 - 2. Anchor and fasten disconnect switches and enclosed circuit breakers and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
 - 3. Install two rows of steel slotted channel, with a minimum of four attachment points, for each disconnect switch and enclosed circuit breaker.
 - 4. When not located directly on wall, install support frame of steel slotted channel anchored to floor and ceiling structure.
- D. Do not support disconnect switches and/or enclosed circuit breakers by raceway.
- E. Install top disconnect switch and/or enclosed circuit breaker handle a minimum of 3'-6" and maximum of 6'-6" above finished floor.
- F. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A - 486B.
- G. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each switch and/or enclosed circuit breaker using small corrosion-resistant metal screws or rivets. Do not use contact adhesive.
 - 1. Include switch and/or enclosed circuit breaker name, amperage, voltage, phase, and number of wires.
- H. Install fuses in fusible switches at job site per requirements in Section 26 2813 – Fuses.

3.04 CONNECTIONS

- A. Ground equipment according to Section 26 0526 – Grounding and Bonding for Electrical Systems.
- B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.05 FIELD QUALITY CONTROL

- A. Inspect for physical damage, proper alignment connections, anchorage, and grounding.
- B. Correct malfunctioning units on-site and retest to demonstrate compliance. Remove and replace with new units and retest.
- C. Test disconnect switches and/or enclosed circuit breakers per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.
- D. Interpret test results in writing and submit to Engineer.

3.06 REPAINTING

- A. Remove paint splatters and other marks from surface of equipment.
- B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.07 ADJUSTING

- A. Circuit Breakers: Set field-adjustable trip settings or change the trip settings recommended by the overcurrent protective device coordination study per Section 26 0573 – Power System Studies.

3.08 CLEANING

- A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION

**SECTION 26 2913
ENCLOSED CONTROLLERS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 0526 – Grounding and Bonding for Electrical Systems
- C. Section 26 0529 – Hangers and Supports for Electrical Systems
- D. Section 26 0533 – Raceway and Boxes for Electrical Systems
- E. Section 26 0553 – Electrical Systems Identification
- F. Section 26 2813 – Fuses

1.02 DESCRIPTION

- A. Section includes enclosed manual and magnetic motor controllers and enclosed contactors.
- B. Motors shown on the drawings or specified in other Divisions of these specifications shall be provided with motorized equipment and connected under this section. Provide motor controllers and power circuit disconnect devices for all motors, unless shown or specified to be furnished with motorized equipment under other Divisions of these specifications, and/or by others, for installation by this contract.
- C. Variable-frequency controllers furnished by Division 20 for installation by Division 26.
- D. Motor Voltage Information:
 - 1. Voltages available are: 208 and 480 V, 3-phase and 120, 208 and 277V single phase. Circuits are designed for motors with voltage ratings as follows:
 - a. Smaller than 1/2 hp motors: 115 V, single phase.
 - b. 1/2 hp motors and larger: 200 and 460 V, 3-phase.

1.03 REFERENCE STANDARDS

- A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting
- B. NEMA AB 1 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures
- C. NEMA 250 – Enclosures for Electrical Equipment (1000 V Maximum)
- D. NEMA ICS 2 – Industrial Control and Systems: Controllers, Contactors and Overload Relays, Rated Not More Than 2000 VAC or 750 VDC
- E. NEMA ICS 4 – Industrial Control and Systems: Terminal Blocks
- F. NEMA ICS 5 – Industrial Control and Systems: Control Circuit and Pilot Devices
- G. NEMA ICS 6 – Industrial Control and Systems: Enclosures
- H. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
- I. NEMA MG 1 – Motors and Generators
- J. NFPA 70 – National Electrical Code
- K. UL 98 – Enclosed and Dead Front Switches
- L. UL 486A-486B – Wire Connectors
- M. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures
- N. UL 508 – Industrial Control Equipment

1.04 SUBMITTALS

- A. Product Data:
 - 1. Motor controllers: Submit catalog cut sheets showing voltage, size, rating and size of switching and overcurrent protective devices, dimensions, and enclosure details.
 - 2. Contactors: Submit catalog cut sheets showing voltage, size, current rating, dimensions, and enclosure details.
 - 3. Factory settings and time-current curves of individual protective devices.

4. Confirm motor sizes and voltages with submittals of other Divisions of specifications, and/or by others, prior to Section submittals.
- B. Manufacturer's Installation Instructions:
 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and/or starting of product.
- C. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
- D. Closeout Submittals:
 1. Project Record Documents:
 - a. Record actual locations and ratings of enclosed motor controllers and enclosed contactors.
 2. Operation and Maintenance Data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
 - b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.05 QUALITY ASSURANCE

- A. Obtain motor controllers, and contactors from one source and by single manufacturer.
- B. Regulatory Requirements:
 1. Comply with NFPA 70 for components and installation.
 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

1.07 WARRANTY

- A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.08 MAINTENANCE

- A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 1. Spare pilot lights: Furnish 1 spare lamp for every 5 installed units, but not less than 1 set of 3 of each kind.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Schneider Square D
- B. ABB-GE Industrial Solutions
- C. Eaton Cutler-Hammer
- D. Siemens
- E. Allen Bradley

2.02 MANUAL MOTOR CONTROLLERS

- A. Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for small motors, with bimetal type overload relay, and toggle operator.

2.03 FRACTIONAL-HORSEPOWER MANUAL CONTROLLERS

- A. Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with bimetal type overload relay, and toggle operator.

2.04 MOTOR STARTING SWITCHES

- A. Description: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, with toggle operator.

2.05 FULL-VOLTAGE NON-REVERSING MAGNETIC MOTOR CONTROLLERS

- A. Description: NEMA ICS 2, AC general-purpose, Class A, magnetic controller for induction motors rated in horsepower, three-phase and single-phase, as scheduled, except where single-phase motors scheduled to be provided with built-in overload elements:
1. Size 1 minimum
 2. Control Voltage: 120 V, 60 Hz
 3. Overload Relays: NEMA ICS 2, solid-state bimetal, 1 overload relay per phase:
 - a. Solid-state type:
 - 1) Class 10, 20, 30 inverse-time tripping characteristics.
 - 2) Non-volatile operating memory.
 - 3) 3:1 current adjustment range.
 - 4) Phase loss/phase unbalance protection.
 - 5) Ambient temperature insensitive.
 - 6) Self-powered.
 - 7) Manual reset. Automatic recent not acceptable.
 - 8) Manual trip.
 - 9) Visible trip indication.
 - 10) One normally open and 1 normally closed isolated auxiliary contact.
 - b. Bimetallic type:
 - 1) Class 10, 20, 30 inverse-time tripping characteristics.
 - 2) Manual reset.
 - 3) Ambient temperature compensated bimetallic
 - 4) One normally open and one normally closed isolated auxiliary contact.
 4. Features:
 - a. Auxiliary Contacts: NEMA ICS 2, 2 each normally open and normally closed contacts in addition to seal-in contact.
 - b. Pushbuttons: Recessed type.
 - c. Pilot Lights NEMA ICS 5: push-to-test LED type.
 - d. Hand-Off-Auto (H-O-A) Selector Switches: Rotary type.
 - e. Control Power Transformers: 120V secondary, adequate capacity to operate connected pilot, indicating and control devices, plus 100% spare capacity in each motor controller, but not less than 100VA. Fused primary and secondary, and unfused leg of secondary bonded to enclosure.
 - f. Terminals: NEMA ICS 4.
 - g. Other accessories detailed or required by drawings.

2.06 MOTOR CONTROLLER ACCESSORIES

- A. Factory installed devices in controller enclosure, unless otherwise indicated, as follows:
1. "On-Off" and "Start-Stop" pushbutton stations, pilot lights, selector switches: NEMA ICS 2, heavy duty type.
 2. 120 V control circuits and pilot light, unless noted otherwise.
 3. Red pilot light to indicate motor operation.

4. Green pilot light to indicate motor stopped.
 5. Minimum wire size for control circuits: #14 AWG.
 6. Stop and Lockout Pushbutton Station: Momentary-break pushbutton station with a factory-applied hasp arranged so a padlock can be used to lock pushbutton in depressed position with control circuit open, where indicated.
- B. Control services: As scheduled on motor schedule or indicated.

2.07 GENERAL PURPOSE MAGNETIC CONTACTORS

- A. Description: NEMA ICS 2, same as magnetic controllers, except without overload protection.
- B. Poles: To match circuit configuration and control function.
- C. Configuration: Electrically held
- D. Contact Rating: Match branch circuit overcurrent protection.

2.08 LIGHTING MAGNETIC CONTACTORS

- A. Description: NEMA ICS 2, same as magnetic controller, except without overload protection.
- B. Poles: To match circuit configuration and control function.
- C. Configuration: Electrically held
- D. Contact Rating: Match branch circuit overcurrent protection.

2.09 LUGS

- A. Labeled for 75°C copper and aluminum conductors.
- B. Multiple lugs to match number of conductors per phase.
- C. Termination of field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.
- D. For equipment specified in this section and for equipment furnished under other Divisions of this specification and/or by others.

2.010 MOTOR CONTROLLERS AND CONTACTOR ENCLOSURES

- A. NEMA 250, NEMA 1CS 6.
- B. NEMA Type 1, Type 3R (outdoor locations) enclosure.
- C. Code-gauge galvanized steel.
- D. Manufacturer's standard gray enamel finish over prime coat.
- E. Surface-mounted.

PART 3 - EXECUTION

3.01 COORDINATION

- A. Coordinate motor control wiring with Division 23 of these specifications.
- B. Coordinate motor sizes and voltages with submittals of other Divisions of these specifications and/or by others.
- C. Verify with manufacturer that "touch-up" paint kit is available for repainting.

3.02 EXAMINATION

- A. Examine areas and surface to receive motor controllers and contactors for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Verify that space indicated for motor controllers and contactors mounting meets code-required working clearances.
- C. Notify Architect/Engineer of any discrepancies prior to submittal of product data.

3.03 INSTALLATION

- A. Install motor controllers and contactors in accordance with ANSI/NECA 1.
- B. Install level and plumb, in accordance with manufacturer's written instruction.
- C. Motor controllers and contactors mounting:
 1. Fasten motor controllers and contactors firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.

2. Anchor and fasten motor controllers and contactors and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
3. Install two rows of steel slotted channel, with minimum of four attachment points, for each motor controller and contactor.
4. When not located directly on wall, install support frame of steel slotted channel anchored to floor and ceiling structure.
5. Do not support motor controllers and contactors only by raceway.
- D. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- E. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each motor controller and contactor, using small corrosion resistant metal screws or rivets. Do not use contact adhesive:
 1. Indicate motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage/phase rating, and fuse size and type, when applicable.
- F. Connect each motor terminal box to rigid conduit system with maximum 18" of flexible liquid-tight metal conduit. Install conduit per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.
- G. Check for proper rotation and phase relationship of each motor.
- H. Install fuses in fusible switch at job site pre requirements in Section 26 2813 – Fuses.
- I. Control Wiring Installation:
 1. Install wiring between motor control devices according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.
 2. Install motor control wiring in accordance with control wiring diagrams and in raceways where indicated or required by contract drawings.
 3. Bundle, train, and support wiring in enclosures.
 4. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - a. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - b. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.04 APPLICATION

- A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, and configuration of pilot device and control circuit affecting controller functions.

3.05 CONNECTIONS

- A. Provide green wire ground through flexible conduit to interconnect motor frame and rigid conduit system.
- B. Ground and bond motor controller and contactor enclosures according to Section 26 0526 – Grounding and Bonding for Electrical Systems.
- C. Connect power and control wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.
- D. Connect control wiring for operation, control and supervision of motorized equipment as shown on drawings and/or specified in this and other Divisions of these specifications.

3.06 FIELD QUALITY CONTROL

- A. Inspect motor controllers and contactors for physical damage, proper alignment, connections, anchorage, and grounding.

- B. Correct malfunctioning motor controllers and contactors on-site and retest to demonstrate compliance. Remove and replace with new units and retest.
- C. Test continuity of each circuit.
- D. Test motor controllers per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.
- E. Interpret test results in writing and submit to Engineer.

3.07 REPAINTING

- A. Remove paint splatters and other marks from surface of equipment.
- B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.08 ADJUSTING

- A. Set field-adjustable circuit breakers trip settings or change the trip settings as indicated on drawings.
- B. Adjust motor circuit protectors.

3.09 CLEANING

- A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION

**SECTION 26 3213
ENGINE GENERATORS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 23 2118 – Pipe and Pipe Fittings
- B. Section 26 0000 – General Electrical Requirements
- C. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables
- D. Section 26 0526 – Grounding and Bonding for Electrical Systems
- E. Section 26 3623 – Automatic Transfer Switches

1.02 DESCRIPTION OF SYSTEM

- A. Section describes complete package generator set, unit-mounted radiator cooling system, microprocessor based control and monitoring panel, battery and charger, Building Management System (BMS) communications module, remote annunciator, drop over sound attenuated enclosure.
- B. Package generator set rated for emergency use.
- C. Engine fuel system: natural gas

1.03 REFERENCE STANDARDS

- A. NEMA MG-1 – Motors and Generators
- B. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- C. NFPA 37 - Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines
- D. NFPA 110 – Standard for Emergency and Standby Power Systems
- E. UL 2200 – Stationary Engine Generator Assemblies
- F. IEC8528 Part 4 – Control Systems for Generator Sets

1.04 SUBMITTALS

- A. Shop Drawings
 - 1. Submit for engineering review and approval prior to production release. Include the following for engine-generator:
 - a. Outline drawings of equipment showing weights
 - b. Overall dimensions including bolting template and earthquake restraints
 - c. Right hand, left hand, end, and top views of proposed assembly
 - d. Battery, battery rack, battery charger, and wiring diagrams
 - e. Vibration isolation bases, mounts, and hangers
 - f. Exhaust silencer and flexible fittings
 - g. Stub ups for fuel
 - h. Power and control wiring entrance locations
 - i. Main circuit breaker size, location, and required clearance
 - j. Lug sizes and locations
 - k. Engine-generator control panel drawings showing devices to be provided, with each device referenced to material list with complete description for device.
 - l. Weather protective enclosure installation drawings, structural calculations, lighting fixture catalog cut, conduit, and wiring.
 - m. Enclosure sound performance data
 - n. Muffler characteristics
 - o. Calculations for starting based on step loads outlined in Paragraph 2.2, B.5.
 - p. Factory certified prototype test report indicating fuel efficiency and emission levels
 - 2. Information on engine characteristics:
 - a. Make, type, and number of cylinders

- b. Brake horsepower (bhp) available
 - c. Jacket water heat rejection
 - d. Cooling pump characteristics
 - e. Exhaust flow rate and temperature at 25, 50, 75, and 100% rated load
 - f. Ventilation requirements
 - g. Combustion air requirements
 - h. Fuel consumption rates at 25, 50, 75, and 100% rated load
 - i. Liquid refill capacities
 - j. Exhaust backpressure limitation
 - k. Type and manufacturer of governor
 - l. Alternator size to limit voltage dip to 10%
3. Information on generator characteristics:
- a. Make and type
 - b. Type of construction and overspeed capabilities
 - c. Temperature rise
 - d. Regulation characteristics
 - e. Ventilation requirements
 - f. Type of winding insulation
 - g. KW power factor
 - h. Type of exciter and voltage regulator
- B. Interconnection detail drawing showing control and power connections in complete standby system. Control connections between components are to be labeled with identical nomenclature. Coordinate with generator manufacturer.
- C. Accessories including fuel lines, flexible exhaust couplings, exhaust flange, and other exhaust system components.
- D. Complete review of this specification, noting for each paragraph whether or not proposed equipment complies with project specifications, or deviates in some fashion. Justification must be provided for each deviation.
- E. Complete test specification detailing testing procedure to be used to verify performance of equipment provided.
- F. Recommended spare parts lists.
- G. Test Reports:
- 1. Submit certified factory tests report on engine-generator delivery. Alarms, sensors, and meters must be tested and certified.
 - 2. Submit, upon completion of installation and testing of engine-generator sets, certified test reports from load tests for each engine-generator.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Handle equipment in accordance with manufacturer's written instructions. One copy of instructions is to be included with equipment at time of shipment. Maintain factory bracing, packaging, and wrapping.

1.06 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Section 01 7700 - Closeout Procedures and herein below.
- B. Submit Operation and Maintenance (O&M) manuals to Engineer for review 60 days prior to acceptance of unit.
- C. Installation, maintenance, and operating instruction manuals shall include, but not limited to, the following:
 - 1. 100% accurate system "as-installed" drawings, interconnect diagrams, schematic diagrams, wiring diagrams, individual sub-system component manuals, operation procedures, system description with theory of operation, maintenance schedules and

- procedures, original programmed settings and parameters, and other information necessary for the Owner to maintain, operate, test, and troubleshoot system.
2. The O&M manual shall contain step-by-step instructions for startup and shutdown. The first page shall contain name, address, and phone number of local representative to be called for service or parts. Follow with complete parts lists by actual ordering catalog numbers. O&M manual also shall contain four copies each of test record forms and service record forms for Owner use. Forms shall show proper interval for testing, servicing, and replacing of components, lubrication, filters, antifreeze, etc., including recommended specifications and fluid levels for lubricants.
 3. Recommended spare parts list (with pricing) for 2 yrs of operation.
- D. O&M manuals shall not solely rely on sub-component manuals. Thorough consolidation of operating and maintenance information shall be available in system overview guide. Include major components of system in overview.
 - E. Turn final reviewed manuals over to Owner prior to conducting training of Owner personnel.
 - F. Seal single copy of service record forms, recommended operation and service practices for unit in plastic and wall mount in weather-protective enclosure.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Acceptable Manufacturers:
 1. Engine Generator Set - Caterpillar, Cummins, MTU Onsite Energy, Kohler
 2. Exhaust Silencer – Maxim, Nelson, or approved equal
 3. Isolation equipment
 4. Battery charger – Sens, La Marche, Charles Industries

2.02 RATINGS AND PERFORMANCE

- A. Engine Generator Set
 1. Generator kW Output: As shown on drawings
 2. Altitude 250 ft above sea level in ambient temperature of 104°F
 3. Stable frequency regulation
- B. Alternator
 1. As shown on drawings kVA, .8 Power Factor
 2. 480V, 3 Ph, 60 Hz, 4 Wire Y
 3. Stable voltage regulation 0-full load less than or equal to $\pm .5\%$.
- C. Transient Performance
 1. Engine
 - a. Start and load in 10 seconds per NFPA 110
 - b. Accept 100% block load per NFPA 110
 2. Frequency regulation $\pm .25\%$ no load to full load. $\pm .25\%$ steady state.
 3. Alternator
 - a. 20% Voltage dip
 - b. Step Load Requirements
 - c. AC waveform output contains <5% total harmonic distortion (THD) at full linear load when measured from line to neutral with <3% in any single harmonic, and no third-order harmonics or their multiples.
 - d. Telephone influence factor < 40
 - e. Telephone harmonic factor < 3
 - f. **[XX]** Fault current capability
- D. Factory Prototype Test Certified
 1. Harmonic Distortion Levels
 - a. Demonstrate

2. Airflow Restriction tests
 - a. Demonstrate controlled shutdown after overheating
 3. Unit tested with enclosure
 - a. UL 2200 listed
 4. Air Filter Test
 - a. Demonstrate engine contains engine backfire explosion
- E. Factory Production Test Certified
1. Alternator Impedance to Ground
 2. Dielectric Testing
 - a. At 1000 V and 2 times rated voltage
 3. Maximum kW Rating
 4. Engine Response Time
 5. Alternator Construction Testing
 - a. Impedance Balance Tested
 6. Alternator Insulation Testing
 - a. Surge Tested

2.03 FABRICATION AND MANUFACTURER

- A. Engine:
1. Type: Inline or vee
 2. Rated speed 1800 RPM consistent with engine durability.
 3. Aspiration: Turbo Charged and After Cooled
 4. Horsepower
 - a. Brake Horsepower **[XX]** **[Rule of thumb = 1.6 x kW]**
 5. Displacement: Six or eight cylinders with maximum cubic inch displacement of **[XX]** and a maximum BMEP consistent with engine durability.
 6. Liquid cooled
 7. Fuel Type: Natural gas.
 8. Engine accessories:
 - a. Fuel filter
 - b. Lube oil filter
 - c. Intake air filter
 - d. Lube oil cooler
 - 1) Suitable for operation of generator set at full rated load in ambient temperature specified.
 - e. Fuel transfer pump
 - f. Fuel priming pump
 - 1) Engine driven positive displacement, mechanical, full pressure
 - g. Gear driven water pump
 - h. Electronic direct fuel injection or have suitable emission control equipment
 - i. Electric speed sensing governor capable of isochronous regulation.
 - j. Safety-shut-offs for:
 - 1) High water temperature
 - 2) Low oil pressure
 - 3) Overspeed
 - 4) Overcranking
 9. EPA Certified Tier 2
- B. Cooling System:
1. Engine skid mounted, engine-driven radiator with blower type fan, sized to maintain safe operation at 122°F ambient temperature.

2. Provide radiator with:
 - a. Motor-driven fan with voltage same as generator
 - b. Motor Starter
 - c. Initiating contacts to actuate on generator startup
 - d. Connect to generator distribution system
 - e. Core guard
 - f. Fan guard
 - g. Mounting hardware
 - h. Direct adapter flange. Ductwork with flexible connection between radiator and exhaust plenum to be provided by Division 23. Coordinate with Division 23.
 - i. Flexible pipe connections at engine and radiator.
 - j. Supply power for fans and pumps on remote radiators from a tap at generator output terminals or ahead of first load circuit overcurrent protective device.
 - k. Heat exchangers
 3. Block Heater
 - a. Water Jacket Heater: Circulating
 - b. Maintain engine jacket water to 110°F in ambient temperature of 30°F
 - c. Heater to be equipped with thermostatic switch.
 - d. Single phase 208V
 - e. Provide two heaters, 4500 W each minimum.
 4. Fill engine cooling system with solution of 50/50 mix ethylene glycol at initial fill.
- C. Exhaust System:
1. Furnish critical type exhaust silencer:
 - a. Sized according to manufacturer's recommendations
 - b. Mount so weight is not supported by engine
 - c. Flexible exhaust fitting
 - d. Installation inside drop over enclosure.
 2. Condensate Traps
 - a. Drain plug at low point of muffler
 3. Thermal Expansion
 - a. Stainless steel exhaust flex to accommodate thermal growth and vibration isolation
 4. Exhaust Blankets
 - a. 1" high temperature fiberglass cloth wrap
 - b. Coordinate with weather protective enclosure.
 5. Thimble
 - a. Pipe and wall of compatible construction
 6. Acceptable Back Pressure
 - a. Size silencer and exhaust pipe so exhaust back pressure does not exceed maximum limitations specified by generator set manufacturer.
 7. Exhaust clearing area
- D. Starting System
1. Provide DC electric starting system with positive engagement drive. Provide DC voltage recommended by manufacturer.
 2. Provide fully automatic start-stop controls.
 3. Provide cycle cranking to open and lock out start circuit after 3 attempts to start failed engine start.
 4. Batteries
 - a. Provide sealed lead-acid storage battery set:
 - 1) Heavy duty diesel starting type
 - 2) Voltage compatible with starting system voltage

- 3) Capacity to provide for 1-1/2 minutes total cranking time at -17°C(0°F) without recharging. In accordance with NFPA Level 1.
 - b. Provide vinyl coated steel battery rack.
 - c. Provide starting battery heater:
 - 1) Heater plate under battery
 - 2) Heater type blanket around battery case
 - 3) Thermal switch - heater control relay
 - 4) 120 VAC input
 - d. Battery cables and clamps
 5. Battery Charger
 - a. Dual Rate Battery Charger
 - 1) Constant current, and float equalized
 - b. Charger Accessories:
 - 1) Overload protection
 - 2) ±1% line and load regulation
 - 3) Electronic current limit output 105%
 - 4) DC ammeter and voltmeter.
 - 5) UL 1236 listed and meets NFPA 110 requirements
 - 6) Output protection
 - 7) Temperature compensation
 - 8) Enclosed in NEMA 1 aluminum or stainless steel enclosure
 - 9) Form C contacts for the following alarms
 - a) AC fail
 - b) Low battery volts
 - c) High battery volts
 - d) Charger fail
 - e) Battery fault
 6. AC input voltage: 208V
 7. When installed on the engine generator set, mount on vibration isolators.
- E. Speed Control
1. Electronic: Isochronous
- F. Alternator:
1. Maximum temperature rise 135°C at 40°C ambient
 2. Synchronous type
 3. Self ventilated
 4. Drip-proof construction
 5. Directly connected to engine flywheel housing with a flex coupling
 6. Capable of sustaining 300% overcurrent for 10 seconds under a 3 Ph symmetrical short circuit
 7. 120 V Anti-Condensation heater
 8. Subtransient Reactance limited to 12%
 9. Insulation
 - a. Complies with NEMA (MG1-33.4)
 - b. Class H Insulation Systems
 - 1) UL 1449 recognized
 - 2) Vacuum impregnated with epoxy varnish
 - 3) Fungus resistant
 10. Permanent magnet brushless excitation (PMG)
 - a. PMG shall derive excitation current from pilot exciter mounted on the rotor shaft. It is to be able to sustain 300% of rated current for ten seconds during a fault condition.

11. Rotor
 - a. 4 pole
 - b. Winding
 - 1) Wet layer wound
 - c. Varnish process
 - 1) Epoxy based material applied to each layer of magnet wire
 - d. Coil supports
 - 1) Driven through flexible coupling to ensure permanent alignment.
 - e. End winding spacing
 - f. Amortisseur windings
 - g. Bearings
 - 1) Sealed
 - 2) Single
12. Stator
 - a. 3 Ph winding
 - b. Laminations
 - c. Cooling air passages and fan
 - 1) Provide space heater to keep alternator free of moisture. Space heater to be 1500 W, 120 VAC, 1 Ph.
 - d. Welded laminations to prevent cutting of wires
 - e. Skewed stack to minimize slot ripple on output voltage and produce smooth voltage waveform.
 - f. Pitch – Skewed design to optimize efficiency and minimize total harmonic distortion.
 - g. Varnish process
 - 1) 2 dips and bakes using Class A impregnating varnish
13. Alternator Components
 - a. Solid state design digital voltage regulator:
 - 1) Performance
 - a) Microprocessor based.
 - b) Programmable
 - c) Regulation: $\pm .25\%$ at any constant load for any load from 0% to 100% of pf rating.
 - d) 3 Ph, true RMS sensing
 - e) PMG input, engine unloading
 - f) Design insensitive to severe, load induced wave shape distortion from SCR or thyristor circuits such as those used in battery charging, UPS, and motor speed control equipment loads.
 - g) Controls to limit build-up of AC generator voltage to provide a linear rise and limit overshoot.
 - h) Digital adjustments for out voltage adjustment gain, damping and frequency rate-off.
 - i) System setup controls and fault alarms.
 - 2) Protection
 - a) Over-excitation protection
 - b) Electronic voltage buildup protection
 - c) Loss of sensing protection
 - d) Temperature compensation
 - e) Limitation of voltage overshoot on startup
 - 3) Features
 - a) Parallel support

- b) VAR/PF control
- 4) Environmentally sealed
- 5) UL 508A listing
- b. Output Circuit Breaker(s)
 - 1) Two 100% thermal magnetic rated circuit breakers
 - 2) Adjustable long time, long time delay, short time, and short time delay curve shaping elements
 - 3) Shunt Trip for integration with load bank controls
 - 4) Solid state trip fixed mounted insulated case generator mounted circuit breaker
 - 5) NEC required access in front of breaker
 - 6) Ground fault alarm only: Monitoring relay for breaker 1000A and above. Relay to be adjustable from 3.8 – 1200A and include an adjustable time delay of 0-10S.
- G. Controls:
 - 1. NFPA 110 listed
 - 2. Micro-processor based solid state controls to automatically start, protect and monitor engine-generator set with panel illuminating lighting and digital display.
 - 3. Control panel includes:
 - a. Solid state trip main circuit breaker
 - b. Motor starting switch
 - c. Electrically operated fuel control
 - d. Relay to disconnect battery charger during cranking
 - e. Switching lamps and meters to be oil tight and dust tight. All active components to be installed within a NEMA 3R enclosure. There shall be no exposed components with door open operating 750 V.
 - f. Protective relays to open main circuit breaker and shut down and lockout engine on abnormal conditions including:
 - 1) NFPA 20-9.6.2.2 requires that certain safety devices associated with a generator be disabled when that generator serves a fire pump. Removal of some of the safety devices in the following section may put the emergency standby source at risk. Engineer should consider use of a dedicated standby generator or service for the fire pump.
 - 2) Overspeed
 - 3) Operation of Remote Stop
 - 4) Overcrank
 - 5) Low lube oil pressure
 - 6) High Engine Temp
 - 7) Low coolant level
 - 8) Fail to crank
 - 9) Dead battery
 - g. Monitoring items shall include but is not limited to the following items and control:
 - 1) Coolant temperature
 - 2) Oil pressure
 - 3) Battery voltage
 - 4) RPM
 - 5) Voltmeter, 3-1/2" dual type, 0.5% accuracy with selector switch
 - 6) Ammeter, 3-1/2" dual type, .05% accuracy with selector switch
 - 7) Frequency meter, 55-65 Hz \pm 0.125 Hz.
 - 8) Running Time Meter (hours and 1/10 hours)

- 9) AC power metering to be 0.5% accuracy and include frequency, phase, selector switch with real time power metering including, kW, kVA, kVAR, kWh, PF, % of rated load.
- h. Control Items:
 - 1) Voltage level adjustment rheostat
 - 2) Overspeed level adjustment
 - 3) Overvoltage level adjustment
 - 4) Undervoltage level adjustment
 - 5) Overfrequency level adjustment
 - 6) Underfrequency level adjustment
 - 7) Position function switch(es) marked AUTO, MANUAL RUN, OFF/RESET and STOP
 - 8) 4 NO and 4 NC dry contacts for local and remote alarms, wired to terminal strips.
 - 9) Emergency off mushroom button
 - 10) Automatic remote start capability. Engine cranking system to permit minimum 4 cranking attempts of 10 seconds (adjustable) duration with rest of periods of 10 seconds (adjustable).
 - a) Overcrack lockout shall occur after 4 cranking attempts.
- i. In accordance with NFPA 110, Level 1, control panel shall furnish battery-powered individual visual alarm indicator functions at battery voltage and visual and audible pre-alarm:
 - 1) Overcrank
 - 2) Low water temperature
 - 3) High engine temperature pre-alarm
 - 4) High engine temperature
 - 5) Low lube oil pressure pre-alarm
 - 6) Low lube oil pressure
 - 7) Overspeed
 - 8) Low fuel main tank
 - 9) Low coolant level
 - 10) EPS supplying load
 - 11) Control switch not in automatic position
 - 12) High battery voltage
 - 13) Low cranking voltage
 - 14) Low voltage in battery
 - 15) Battery charger ac failure
 - 16) Lamp test
 - 17) Contacts for local and remote common alarm
 - 18) Low starting air pressure
 - 19) Low starting hydraulic pressure
- j. Engine shut down, with audible alarm:
 - 1) Low oil pressure
 - 2) High engine temperature
 - 3) Overcrank
 - 4) Overspeed
 - 5) Remote Emergency Stop
 - 6) Reverse power
 - 7) Low-coolant level
- k. Status report:
 - 1) Engine running

- 2) Circuit breaker open
- 3) Circuit breaker closed
4. Visual alarm resettable only after fault condition has been corrected.
5. Audible alarm shall include silencing circuit, which, after activation, will permit annunciation of subsequent failures.
6. Control Panel mounting:
 - a. Mounted on engine generator set in NEMA 1 enclosure on shock isolators
 - b. Wall mounted in NEMA 1 enclosure
 - c. Free standing in NEMA 1 enclosure
7. Provide remote annunciator panel
 - a. Compliant with NFPA Level 1 requirements.
- H. Isolate engine generator set from building structure and from connecting services.
 1. Separately derived grounding system. Connect generator ground as shown on drawings to grounding electrode system.
- I. Termination Bars and Connections:
 1. Silver- or tin-plated copper bus bars for terminating cables.
 2. Standard NEMA standard bolt hole spacing, for 3 Ph and neutral, within generator connection box with gasketed bolt on cover.
 3. Engine-generator set control interfaces to other system components to be made on a permanently labeled terminal block assembly. Provide labels describing connection points.
 1. Connections to engine-generator set: Flexible or isolation type connections. Include electrical, fuel, exhaust, and ventilation connections.
- J. Equipment Bases:
 1. Mount complete unit on a structural steel sub-base, rectangular in shape, with sufficient rigidity to maintain alignment of generator set. Provide perimeter beams with minimum depth equal to 1/10 of longest dimension of base, except beam depth need not exceed 14" provided that deflection and misalignment are kept within acceptable limits as determined by manufacturer. Engine-generator set to be statically and dynamically balanced at factory. Peak-to-peak amplitude of vibration velocity in horizontal, vertical, and axial direction shall not exceed 0.65" per second at main structural components.
 2. Engine-generator set weight distribution is to be considered to provide uniform deflections.
 2. Bases shall provide equipment alignment and assure uniform weight distribution. Provide side brackets on bases to contain isolating mounts and reduce total installed heights of equipment.
- K. Vibration Isolators:
 1. Prevent equipment vibrations from being transmitted to enclosure.
 2. Required between the structural steel sub-base and concrete housekeeping pad.
 3. Steel or cast iron top and bottom housings incorporating 1 or more steel springs with built-in leveling bolts and built-in resilient chocks to control oscillation and withstand lateral forces in all directions.
- L. Custom Walk-in Weather Protective Enclosure
 1. Include sub-base tank as described in this specification.
 2. NEMA 3R rated
 - a. Sound attenuated enclosure to reduce sound level of engine generator set while operating at full rated load and ventilation to a maximum of 60 dbA at property line from engine generator in free-field environment.
 3. Overall Size:
 - a. Drawings show generator footprint, which is maximum allowed for available space.
 - b. Air intake limitations as shown on drawings. System operating within space limitations indicated above.

4. Construction:
 - a. Welded, 12 ga galvanized steel to ASTM A-446.
 - b. Walls: 3" thick satin coat steel formed panels with wall studs 16" on center designed to withstand wind loads as required by UBC.
 - c. Roof: 3" thick with 3" deep cross members every 24" minimum, seal welded construction, and crowned to prevent ponding of water.
 - d. Interior insulation: 3" thick rigid fiberglass. Insulation lined with 22 ga perforated steel screwed in place. Intake and discharge to be lined with poly prior to lining with 22 ga perforated steel.
 - e. Interior liner: 22 ga perforated galvanized steel.
 - f. Base: Nominal 3" x 2" perimeter mounting angle with 7/8" diameter anchor holes and suited for seismic hold down.
 - g. Access doors: Minimum two 18 ga galvanized steel doors, each 36" x 80", complete with panic hardware with exterior thumb latch, ball bearing hinges, weather stripping, stainless steel threshold, and drip edge.
 - h. Lifting lugs
5. Ventilation:
 - a. Intake: complete with motorized-type damper, hood with silencer, flex connections, and 1/2" x 1/2", 16 ga galvanized bird screen.
 - b. Discharge: complete with gravity-type damper with discharge duct, hood with silencer, flex connector, and 1/2" x 1/2", 16 ga galvanized bird screen.
6. Electrical:
 - a. Include panelboard wired to the following:
 - 1) 6 battery-powered LED fixtures; battery units shall have a minimum run-time of 90 minutes; Provide Columbia LCL4 with emergency battery pack or approved equal.
 - 2) (2) 3-way switches
 - 3) 2 GFCI duplex receptacles
 - 4) 2 block heaters wired to a junction box local to front of generator set
 - 5) Battery charger
 - 6) Battery heater
 - 7) Space heater
 - 8) 120 V circuit for day tank reverse pump
 - 9) 120 V circuit for day tank controls
 - b. Wiring shall be #12 AWG minimum in surface-mounted EMT conduit with compression fittings.
 - c. Coordinate all loads type, voltage, and rating with engine-generator supplier prior to ordering panel. See panel schedules for connection of loads.
 - d. Provide with 36" space in front of panelboard.
 - e. Provide electrical connections from bottom of enclosure. Water seal around enclosure floor penetrations.
7. Paint:
 - a. Clean surfaces to SSPC-SP1, seams sealed, primed with industrial phenolic primer to 1.5 mils D.F.T. Top coat exterior with Clovacoat epoxy enamel to 2.0 mils D.F.T.
 - b. Coordinate color with Architect.
- M. Outdoor Weather Protective Drop-Over Enclosure:
 1. Rated NEMA 3R
 2. Attenuation:
 - a. Provide engine-generator set with sound-attenuated enclosure. Enclosure will reduce sound level of engine-generator set while operating at full rated load and ventilation

running to maximum of 85 dBA at 1 meter or 77 dBA at 7 meters from engine-generator set in free-field environment.

3. Overall Size:
 - a. Drawings show generator footprint, which is maximum allowed for available space.
 - b. Air intake requirements are to be taken into consideration and shall not prevent enclosure from operating within space limitations indicated above.
 4. Construction:
 - a. Construction to be welded, 14 ga galvanized steel to ASTM A-446.
 - b. Package listed to UL 2200
 - c. Lockable doors
 - d. Minimum 100A accessory distribution panel to power items listed in Paragraph 2.3.L.a.
 - e. Interior lights
 - f. Remote mounted emergency stop button
 - g. Lifting lugs
 - h. Refer to Paragraph 2.3.N for fuel system.
 5. Ventilation:
 - a. Intake: Complete with gravity damper, hood with silencer, flex connections, and 1/2" x 1/2", 16 ga galvanized bird screen to protect against ice and snow.
 - b. Discharge: Complete with gravity-type damper with discharge duct, hood with silencer, flex connector, and 1/2" x 1/2", 16 ga galvanized bird screen.
 6. Paint:
 - a. Clean surfaces to SSPC-SP1, seal seams, prime with industrial phenolic primer to 1.5 mils D.F.T. Top coat exterior with Clovacoat epoxy enamel to 2.0 mils D.F.T.
 7. Power Coat Paint. Selections to include white, beige, ASA61 gray, and manufacturer factory standard. Architect to select.
- N. Fuel System
1. Natural gas
 2. System shall comply with local codes and permitting requirements.

2.04 INTERFACE WITH BUILDING MANAGEMENT SYSTEM (BMS)

- A. Interface shall be as follows:
1. Control panel shall incorporate communication module with digital communication port connection to building control system (BMS) via Ethernet communication.
 2. Communications shall be for the following:

TYPE	CONDITION/DESCRIPTION	RANGE/UNITS
LDI 1	Low lube oil pressure prealarm	
LDI 2	Low water temperature	
LDI 3	High engine temperature prealarm	
LDI 4	Battery charger AC failure	
LDI 5	Spare	
LDI 6	Control switch not in automatic position	
LDI 7	High battery voltage	
LDI 8	Low coolant level	
LDI 9	Low cranking voltage	
LDI 10	Low voltage in battery	
LDI 11	EPS supplying loads	
LDI 12	Generator circuit breaker ground fault	

TYPE	CONDITION/DESCRIPTION	RANGE/UNITS
LDI 13	Low lube oil pressure	
LDI 14	High engine temperature	
LDI 15	Overcrank	
LDI 16	Overspeed	
LDI 17	Remote emergency manual stop switch	
LDI 18	Overcurrent (circuit breaker trip and lockout)	
LDI 19	Reverse power relay trip	
LDI 20	Spare	
LDI 21	Engine running	
LDI 22	Generator running	
LDI 23	Generator circuit breaker open	
LDI 24	Generator circuit breaker closed	
LDI 25	Generator circuit breaker failed to close	
LDI 26	Spare	
LDI 27	Control voltage failure	
LDI 28	Auto start	
LDI 29	Battery charger failure	
LDI 30	Spare	
LDI 31	Spare	
LDI 32	Spare	
LDI 33	Spare	
LDI 34	Spare	
LDI 35	Spare	
LDI 36	Spare	
LDI 37	Spare	
LDI 38	Spare	
LDI 39	Spare	
LDI 40	Spare	
LDI 41	Spare	
LDI 42	Spare	
LDI 43	Spare	
LDI 44	Spare	
LDI 45	Spare	
LDI 46	Spare	
LDI 47	Spare	
LDI 48	Spare	
LDI 49	Spare	
LDI 50	Spare	
LDI 51	Spare	
LDI 52	Spare	

TYPE	CONDITION/DESCRIPTION	RANGE/UNITS
LDI 53	Spare	
LDI 54	Spare	
LDI 55	Spare	
LDI 56	Air damper closed	
LDI 57	System test mode (lamp test)	
LDI 58	Spare	
LDI 59	Spare	
LDI 60	Spare	
LDI 61	Spare	
LAI 1	Generator phase A-B voltage	Volts
LAI 2	Generator phase B-C voltage	Volts
LAI 3	Generator phase C-A voltage	Volts
LAI 4	Generator phase A current	Amperes
LAI 5	Generator phase B current	Amperes
LAI 6	Generator phase C current	Amperes
LAI 7	Total real power	KW
LAI 8	Total apparent power	KVA
LAI 9	Total reactive power	KVAR
LAI 10	Generator power factor	
LAI 11	Generator phase A frequency	Hertz
LAI 12	Generator phase B frequency	Hertz
LAI 13	Generator phase C frequency	Hertz
LAI 14	Battery voltage	Volts
LAI 15	Engine oil pressure	KPA
LAI 16	Engine speed	RPM
LAI 17	Engine water temperature	Degrees Centigrade
LAI 18	Engine running time	Hours
LAI 19	Spare	
LAI 20	Spare	
LAI 21	Spare	
LDO 1	Remote fault reset	
LDO 2	Remote start initiative	
LDO 3	Cool down override control	
LDO 4	Phase select	
LDO 5	Load adding and load shedding	

Notes:

LDI - LAN: Digital Input from control panel communication module to BMS via Ethernet communication.

LAI - LAN: Analog Input from control panel communication module to BMS via Ethernet communication.

LDO - LAN: Digital Output from BMS to communication module via Ethernet communication.

LAN – Local Area Network

3. Provide all additional information as required for a complete and operable system.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install engine-generator set and associated equipment as indicated. Coordinate final location of equipment with General Contractor. Final location of equipment to be reviewed with Engineer prior to installation.
- B. Install equipment in accordance with manufacturer's recommendations. Provide equipment protection during and subsequent to installation.

3.02 ACCEPTANCE TESTS

- A. Testing by Electrical Contractor

3.03 LOAD TEST

- A. Conduct load testing of engine-generator set, under direct supervision of factory-authorized representatives of manufacturers of engine-generator set and auto-transfer switch.
- B. Provide external load bank control power for the load bank to avoid control drop-out during 100% block load.
- C. Generator start-up and load bank testing to be coordinated with project commissioning to advance project schedule and save costs.
- D. Installation is NFPA 110, Level 1 – Authority Having Jurisdiction must be given notice prior to testing as required in NFPA 110.
- E. Testing to include cold start, 25, 50, 75, and 100% step loads (slow addition of load to confirm operation), 50% and 100% block loads (instantaneous load percentages), and 4-hour testing at rated nameplate.
 1. Loading shall be by use of contractor rented portable load banks.
- F. Provide certified results of testing, including frequency and voltage regulation at 25, 50, 75, and 100% of rated load, fuel consumption, exhaust temperature, and exhaust emissions at the above load ratings, actual measured values for pickup and drop out relays for ATS, measured values for time delay relays.
- G. Engine-generator set test results are to be certified to comply with specification parameters or necessary corrective actions implemented and tests repeated until compliance is certified at no additional cost to owner.
- H. At conclusion of testing, service engine-generator set including replacing air, oil and fuel filters, changing lubrication oil, checking and refilling batteries, adjusting fan belts for proper tightness, and refilling of cooling system as required.
- I. Provide fuel for load testing of engine-generator set.

END OF SECTION

SECTION 26 3623
AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0000 – General Electrical Requirements
- B. Section 26 0529 – Hangers and Supports for Electrical Systems
- C. Section 26 3213 – Engine Generators

1.02 DESCRIPTION OF SYSTEM

- A. Provide automatic transfer switch, 3 phase, 60 Hz, 3 pole, with solid neutral for voltage and current as indicated on drawings.

1.03 REFERENCE STANDARDS

- A. ICS 10 Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment
- B. UL1008 Automatic Transfer Switches

1.04 SUBMITTALS

- A. Submit shop Drawings for equipment provided under this Section.

1.05 QUALITY ASSURANCE

- A. Obtain automatic transfer switches from one source and by single manufacturer.
- B. Regulatory Requirements:
 - 1. Comply with NFPA 70 for components and installation.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, fumes, water, corrosive substances, construction debris, and traffic. Provide temporary heaters in switchgear as required to prevent condensation.
- B. Deliver individually wrapped for protection, and mounted on shipping skids. Mark crates, boxes, and cartons clearly to identify equipment. Show crate, box, or carton identification number on shipping invoices.
- C. Use factory-installed lifting provisions. Handle carefully to avoid damage to internal components, enclosure, and finish.

1.07 WARRANTY

- A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Acceptable Manufacturers: Asco by Schneider Electric, Cummins, Russelectric by Siemens, or Zenith by ABB

2.02 AUTO-TRANSFER SWITCH

- A. Auto-transfer switch:
 - 1. Mechanically held, electrically operated type
 - 2. Interlocked to ensure only 2 possible positions, normal and emergency.
 - 3. Rated for continuous duty in unventilated sheet metal enclosure
 - 4. Suitable for all classes of loads at maximum rated voltages

5. Withstand rating that meets or exceeds withstand rating of transfer switch feeder breakers.
6. Shall be open transition type.
- B. Provide main contacts with silver alloy wiping action type protected by arcing contacts.
- C. Provide switch components accessible from front of enclosure.
- D. Provide 3 cycle short circuit rating to guarantee contact opening and no damage when transfer switch is served by molded case circuit breakers.
- E. Provide switch with the following items:
 1. Adjustable 1 to 3 second time delay to override momentary voltage dips and outages.
 2. Time delay on transfer to emergency. Adjustable from 1 to 300 seconds (factory set at 3 seconds).
 3. Time delay on retransfer to normal. Adjustable from 2 seconds to 30 minutes.
 4. Full phase protection consisting of 2 phase relays and one close differential relay. Phase relays shall be set to 70% drop out, 90% pick up, and differential relays set for 92 to 95% pick-up and 83 to 85% drop-out.
 5. Pushbutton reset to normal.
 6. Pushbutton to bypass time delay on retransfer to normal.
 7. Pilot light to indicate normal position.
 8. Pilot light to indicate emergency position.
 9. Auxiliary contact to close when normal power fails.
 10. Auxiliary contact to open when normal power fails.
 11. Auxiliary contact on same shaft as main contacts (closed on normal).
 12. Auxiliary contact on same shaft as main contacts (closed on emergency).
 13. Pushbutton, or selector switch, or graphical display input to provide "Test," "Auto," and "Engine Start."
 14. Contacts to start engine-generator when normal power fails.
 15. Time delay engine start, adjustable from 0 to 5 seconds.
 16. Adjustable time delay on retransfer to normal source with 5 minute unloaded running time of standby plant:
 - a. Minimum delay 2 minutes
 - b. Maximum delay 25 minutes
 - c. Built in circuitry to nullify time delay if emergency source fails and power is available at normal source.
 17. Relay to prevent transfer to emergency until voltage and frequency of generating plant have reached 90% of rated value.
 18. Provide bi-direction in-phase monitor or dual motor operator with programmed neutral to allow voltage decay in motor and transformer circuits.
- F. Bypass/isolation switch:
 1. Dual-source enclosed.
 2. Isolate transfer switch and de-energize for maintenance, testing or repair.
 3. Dual-source operation - bypass either to normal or emergency source directly to load at discretion of operator.
 4. Break-before-make operation of contacts.
 5. Operation - fully mechanical, designed to provide quick-make-quick-break of contacts and only allow switch to be fully closed or fully open with no mid position possible.
 6. Operation - possible regardless of the position or condition of the automatic transfer switch.

2.03 ELEVATOR CONTROL INTERFACE

- A. Provide auxiliary contacts to provide emergency system status to elevator controller.
- B. Contacts required are:
 1. Emergency power signal
 2. Pre-transfer warning signal

- C. Pre-transfer warning signal relay to change state prior to operation of transfer switch in either direction.
- D. These contacts are in addition to other required contacts.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install equipment in accordance with manufacturer's recommendations.
- B. Provide equipment protection during and subsequent to installation.
- C. Provide wiring between transfer switch and elevator controller. Final connections at elevator controller by Elevator Contractor.
- D. Connect transfer switches that are part of fire pump controllers.

3.02 OPERATION

- A. Parallel "start engine-generator" contacts of automatic transfer switches, such that failure of normal source at any switch shall start engine.
- B. Transfer of one switch from normal to emergency shall not preclude any other switch from transferring.
- C. Engine generator cool down cycle shall not start until all transfer switches have timed out back to normal source.

3.03 ACCEPTANCE TESTING

- A. Testing by Electrical Contractor
- B. Perform acceptance testing in accordance with Section 26 0812 – Power Distribution Acceptance Tests.
- C. Adjust or replace equipment as needed to comply with manufacturer's specifications and resubmit corrected test reports.

END OF SECTION

**SECTION 26 4113
LIGHTNING PROTECTION FOR STRUCTURES**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0526 – Grounding and Bonding for Electrical Systems
- B. Section 26 0533 – Raceway and Boxes for Electrical Systems

1.02 DESCRIPTION

- A. Section includes lightning protection systems consisting of air terminals, roof conductors, bonding conductors, down conductors, fastener connections, and grounding.

1.03 REFERENCE STANDARDS

- A. ANSI/NEMA GR1 - Grounding Rod Electrodes and Ground Rod Electrode Couplings
- B. NFPA 70 - National Electrical Code
- C. NFPA 780 - Standard for the Installation of Lightning Protection Systems
- D. UL 467 – Grounding and Bonding Equipment
- E. UL 96 - Lightning Protection Components
- F. UL 96A - Installation Requirements for Lightning Protection Systems

1.04 SUBMITTALS

- A. Product Data:
 - 1. Submit manufacturer's descriptive and technical literature and catalog cuts.
- B. Shop Drawings:
 - 1. Submit installation shop drawings for the overall lightning protection system. Include physical layout of the equipment, mounting details, and relationship to other parts of the work.
 - 2. Submit detail drawings for each major component.
 - 3. Submit location, size, and material of grounding electrodes, and connection type.
 - 4. Submit roof adhesive data for air terminals mounted on single-ply roofing.
- C. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply roofing material.
- D. Copy of Owner's UL Master Label Certificate.
- E. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.
- F. Closeout Submittals:
 - 1. Project record documents:
 - a. Record active location of lightning protection system components.
 - 2. Operation and maintenance data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventative maintenance instructions.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Lightning protection system materials:
 - a. Consists of standard products by a manufacturer regularly engaged in production of lightning protection systems.
 - b. UL Listed
 - 2. Lightning protection system installer: UL Listed.
- B. Regulatory Requirements:
 - 1. Lightning protection system: Comply with NFPA 780, UL 96, and UL 96A.

C. Certifications:

1. Furnish Owner with UL Master Label Certificate upon completion of installation providing proof that the lightning protection system is in compliance with UL 96 and UL 96A standards.

1.06 SEQUENCING

- A. Coordinate installation of lightning protection with installation of other building systems and components, including supporting structures and building materials, metal bodies requiring bonding to lightning protection components, exterior and interior building finishes, and building roofing.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Thompson Lightning Protection Company
B. Harger Lightning Protection, Inc.
C. Heary Brothers Lightning Protection Company, Inc.
D. National Lightning Protection Corporation
E. Erico International Corporation
F. Approved Equal

2.02 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. NFPA 780, UL 96.
- B. Materials: Air terminals, main and cross-run roof conductors, bonding and down conductors, conductor fasteners, air terminal supports, chimney bands, clips, and connections: Class I
1. Air terminals: Solid type with a safety tip, 10" in height minimum, above the object to be protected when spaced at intervals not exceeding 20 ft, with mounting base.
- C. ANSI/NEMA GR1 Grounding Electrodes: 3/4" x 10 ft long copper-clad steel ground rod.
- D. Concrete-Encased Electrodes: As shown on drawings.
- E. Ground Ring Electrode: As shown on drawings.
- F. Ground Connectors: Conform to UL 96
1. Bronze of the clamp type and bronze clamp accessories.
 2. Provide in accordance with the requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.
- G. Galvanic Compatibility of Materials:
1. Air terminals, conductors, fasteners, and connectors shall be galvanically compatible with surfaces they are mounted to.
 2. Copper materials in all locations except where the use of aluminum materials is necessary for galvanic compatibility.
 3. Aluminum materials on copper roofs are not acceptable.
 4. Aluminum materials where mounted on aluminum roofing, siding, or other aluminum surfaces.
- H. Bimetallic fittings when joining metals that are not galvanically compatible.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install lightning protection to comply with UL 96A, NFPA 70, and NFPA 780. Conform to the most stringent requirement in NFPA 780.
- B. Bond exterior metals including flashing, roof drains, vent stacks, fans, water pipes, metal raceways, enclosures, frames, and other non-current carrying metal parts of electrical and mechanical equipment on roof to lightning protection system.
- C. Bond lower end of exhaust ducts, vent stacks, etc., passing through roof.

- D. Run bonding jumpers continuously horizontally or down from point of bond to point of connection to main conductor.
- E. Make down conductors electrically continuous, with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops. Protect down conductors, where necessary, to prevent physical damage or displacement to the conductor. Use PVC Schedule 40 conduits. Provide conduits in accordance with requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.
 - 1. Provide down conductors for every 100 feet of building perimeter.
 - 2. For structural steel construction, utilize steel columns (bond top and bottom) in lieu of down lead conductors – every other column and not to exceed an average of 60 foot spacing.
- F. Conceal system conductors and interior conductors.
- G. Notify Architect at least 48 H before concealing lightning protection system components.
- H. Below-grade or concealed cable connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components.
- I. Exposed cable connections: Use approved mechanical connections.
- J. Air terminals mounted on single-ply roofing: Use adhesive recommended by manufacturer of air terminals and approved by manufacturer of roofing material. Comply with adhesive manufacturer's installation instructions. For roofing work, refer to Division 07 - Thermal and Moisture Protection.
- K. Attach each down conductor to the grounding electrode by exothermic welding.
- L. Provide grounding electrodes with top 2 ft below finished grade.
- M. Ramps and covered passageways shall be protected by the lightning protection system.
- N. For construction utilizing post tensioning systems to secure precast concrete sections, do not use the post tension rods as down conductors. Bond tension rods to the lightning protection and grounding system – follow recommendations of the post tension rod manufacturer.

3.02 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the present of moisture, unless moisture is permanently excluded from the junction of such materials.
- B. Use conductors with suitable protective coatings where conditions would cause deterioration or corrosion of conductors.

3.03 FIELD QUALITY CONTROL

- A. Apply for inspection by Underwriters Laboratories, Inc. (UL) to obtain UL Master Label Certificate.
- B. Verify that lightning protection surge arrestor devices are installed on all incoming power and communications lines, in order to obtain UL Master label Certificate.

END OF SECTION

SECTION 26 4300
SURGE PROTECTIVE DEVICES (SPD)

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0000 - General Electrical Requirements
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems
- C. Section 26 2416.13 - Lighting and Appliance Panelboards
- D. Section 26 2416.16 - Distribution Panelboards
- E. Section 26 2726 - Wiring Devices

1.02 DESCRIPTION

- A. Provide Type 1 Surge Protective Devices (SPD) for the protection of AC electrical circuits formerly known as Transient Voltage Surge Suppression (TVSS) System. Provide high energy surge current diversion and be suitable for application in Type 1 environments.
- B. Modes of Protection:
 - 1. Line to Ground, Line to Neutral and Neutral to Ground for services with a neutral
 - 2. For Services without a neutral, Line to Line and Line to Ground
- C. Provide common and normal modes of protection.

1.03 REFERENCE STANDARDS

- A. ANSI/UL 1449 Surge Protective Devices Fourth or Third Edition
- B. IEEE C62.41 – Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits FIPS PUB 94
- C. IEEE C62.11 – Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (> 1 kV)
- D. IEEE C62.41.1 Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
- E. IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
- F. IEEE C62.45 IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits
- G. IEEE C62.62 IEEE Standard Test Specifications for Surge Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low Voltage (1000V and less) AC Power Circuits
- H. National Electrical Code – Article 285
- I. NEMA LA 1 – Surge Arresters
- J. National Fire Protection Association – NFPA 20, 70, 75, and 780
- K. UL 96A Installation Requirements for Lightning Protection Systems

1.04 SUBMITTALS

- A. Submit Shop Drawings for equipment provided under this Section.
- B. Submit shop drawings and product information for approval and final documentation in quantities listed according to Conditions of the Contract. Identify customer name, customer location, and customer order number.
- C. Submit ANSI/UL 1449 Listing documentation to indicate the following:
 - 1. Short Circuit Current Rating (SCCR)
 - 2. Voltage Protection Ratings (VPRs) for all modes
 - 3. Maximum Continuous Operating Voltage rating (MCOV)
 - 4. Nominal Discharge Current rating (I-n)
 - 5. Type 1 device
 - 6. VPR, MCOV, I-n, and Type 1 information is posted at www.UL.com under Certifications; search using UL Category Code: VZCA. SCCR's are posted in manufacturer's published documentation.

7. UL data and visual inspection takes precedence over manufacturer's published documentation.
- D. Provide shop drawings including manufacturer installation instruction manual and line drawings detailing dimensions and weight of enclosure, internal wiring diagram illustrating all modes of protection in each type of SPD required, wiring diagram showing field connections, and manufacturer's recommended wire and breaker sizes (if required).
- E. Upon request, modules using encapsulation shall be presented without encapsulation for visual inspection, proprietary technology included. MOV type and quantity shall reflect kA ratings on cutsheets, verification of diagnostic monitoring, thermal and overcurrent protection, etc.

PART 2 - PRODUCTS

2.01 MATERIAL

- A. Acceptable manufacturers:
 1. Externally-mounted unit by the power distribution equipment manufacturer.

2.02 PERFORMANCE CHARACTERISTICS

- A. SPD shall bear the UL Mark and shall be Listed to Third Edition of ANSI/UL 1449. "Manufactured in accordance with" is not equivalent to UL Listing and does not meet intent of specification.
- B. Post SPD and performance parameters at www.UL.com under Category Code: VZCA. Products or parameter without posting at UL.com are not approved.
- C. Minimum surge current capacity for Service Entrance units based on 8 x 20 microsecond current waveform:
 1. 200,000 A between each phase for line-to-line mode
 2. 200,000 A each phase for line-to-ground mode
 3. 200,000 A each phase for line-to-neutral mode
 4. 200,000 A for neutral-to-ground mode
- D. Minimum surge current capacity for panelboard units based on 8 x 20 microsecond current waveform:
 1. 80,000 A between each phase for line-to-line mode
 2. 80,000 A each phase for line-to-ground mode
 3. 80,000 A each phase for line-to-neutral mode
 4. 80,000 A for neutral-to-ground mode
- E. Sequential Surge Current Survivability:
 1. 1,000 sequential category surges without failure.
- F. Current Rating:
 1. Rated for continuous current and AIC rating of equipment protected.
 2. Mark SPD Short-Circuit Current Rating on the SPD label.

2.03 OPERATING CONDITIONS

- A. Temperature range: -40°F to 122°F
- B. Relative humidity range: 0 to 95%, non-condensing
- C. Audible noise level: > 40 dBA at 5 ft
- D. SPD Surface Temperature: less than 131°F

2.04 FABRICATION

- A. SPD Modules:
 1. UL Labeled as Type 1 (verifiable at www.UL.com), intended for use without need for external or supplemental overcurrent controls. Protect suppression component of every mode, including N-G, by internal overcurrent and thermal overtemperature controls. SPDs relying on external or supplementary installed safety disconnects do not meet intent of specification.

2. UL Labeled with 20kA I-nominal (I-n) (verifiable at UL.com) for compliance to UL 96A Lightning Protection Mater label and NFPA 780
3. Suppression components: Heavy-duty MOVs, selenium cells, or combination of both.
4. Provide surge current diversion paths for all modes of protection: L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.
5. Provide service entrance SPD audible diagnostic monitoring by way of audible alarm.
6. Provide service entrance SPD with 1 set of NO/NC dry contacts for alarm conditions.
7. Provide visual LED diagnostics including a minimum of 1 green LED indicator per phase, and 1 red service LED. Include an audible alarm with on/off silence function and diagnostic test function (excluding branch).
8. If a dedicated breaker for the SPD is not provided in the switchgear, switchboard, or panelboard include an integral UL Recognized disconnect switch. Dedicated breaker to serve as a means of disconnect for distribution SPDs.
9. Meet or exceed the following criteria:
 - a. ANSI/UL 1449 Listed Voltage Protection Ratings (VPRs) for 6kV 3000A testing as follows:

VOLTAGE	L-N L-G N-G	L-L
208Y/120V	≤800V	≤1200V
480Y/277V	≤1200V	≤2000V

10. ANSI/UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	15%	150V
480Y/277	15%	350V

11. Provide serviceable, replaceable modules (excluding Branch).
 12. Provide warranty for a period of 10 yrs, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period.
- B. Service Entrance:
1. Install 1 primary suppressor external to the service entrance in accordance with manufacturer instructions.
 2. Install SPD on line or load side.
 3. Bond SPD ground to service entrance ground.
- C. Distribution Panelboards:
1. Install 1 suppressor external to each designated distribution panelboard.
 2. Install surge suppression device in accordance with manufacturer instructions.
- D. SPD Low-Impedance Interconnect Cable:
1. Provide low-impedance cable specifically listed for SPD installations.
 2. Low impedance approximately 25% of conventional pipe and wire for improved clamping voltage.

PART 3 - EXECUTION

3.01 APPLICATION OF SPD

- A. Provide UL approved disconnect switch at Service Entrance or Transfer Switch as a means of service disconnect if a breaker sized per manufacturer's recommendations is not available.
- B. Provide independent means of servicing disconnect at Distribution, MCC, and Branch such that the protected panel remains energized. A 30A breaker (or larger based on manufacturer's recommendations) may serve this function.

3.02 INSTALLATION

- A. Install per manufacturer's recommended practices.
- B. Provide short and straight conductors not exceeding 3 ft in length. Manufacturer-approved cables may be used that allow conductor length to extend beyond 3 ft in length without affecting capability of unit.
- C. Input conductors twisted together to reduce inductance.
- D. Avoid 90-degree bends in cable.

3.03 QUALITY ASSURANCE

- A. Factory test system before shipment. Include quality control check, "Hi-Pot" tests at 2 times rated voltage plus 1,000 V, ground leakage tests, and calibration.
- B. Manufacturer Qualifications: Engage a firm with at least 5 yrs experience in manufacturing surge protective devices.
- C. Manufacturer of equipment shall have produced similar electrical equipment for a minimum period of 5 yrs. When requested by Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with requirement.
- D. Provide SPD compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

3.04 FIELD QUALITY CONTROL

- A. Inspections before SPD startup:
 - 1. Visual Inspection:
 - a. Verify installation per drawings.
 - b. Verify phase, neutral, and ground conductors are properly sized and configured.
 - 2. Mechanical Inspection:
 - a. Check connections for tightness.
 - b. Check terminal screws, nuts and/or connectors for tightness.
 - 3. Electrical Inspection:
 - a. Confirm input voltage.
 - b. Confirm phase, neutral and ground connections are proper.

3.05 WARRANTY

- A. Provide 10 yr manufacturer warranty.

END OF SECTION

**SECTION 26 5000
LIGHTING**

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 26 0000 - General Electrical Requirements
- B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables
- C. Section 26 0526 - Grounding and Bonding for Electrical Systems
- D. Section 26 0533 - Raceway and Boxes for Electrical Systems
- E. Section 26 0923 - Lighting Control Devices

1.02 DESCRIPTION OF WORK

- A. Provide complete and fully operational lighting system per Contract Drawings and Specifications.
- B. Luminaires shall be provided complete with necessary accessories for proper installation.
- C. Catalog numbers shown in luminaire schedule are basic luminaire types. Additional features, accessories and options specified, scheduled or necessary for proper installation shall be included.
- D. Specifications and drawings convey the features and functions of luminaires only and do not show every item or detail necessary for the work.
- E. Work includes final aiming and focusing of luminaires under direction of the Architect/Engineer.

1.03 REFERENCE STANDARDS

- A. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems (ANSI)
- B. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems (ANSI)
- C. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems (ANSI)
- D. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility
- E. UL 773 - Plug-in Photocontrols for use with area lighting
- F. UL 924 - Emergency Lighting and Power Equipment
- G. UL 1574 - Track Lighting
- H. UL 1598 - Luminaires
- I. UL 2108 - Low Voltage Lighting Systems
- J. UL 2388 - Flexible Lighting Products
- K. UL 2562 - Pendant Cable
- L. UL 8750 - LED Light Sources for use in Lighting Products
- M. ANSI C78.377 - Chromaticity
- N. IESNA LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products
- O. IESNA LM-80 - Approved Method: Testing Lumen Maintenance of LED Light Sources
- P. IESNA TM21-11 - Projecting Long Term Lumen Maintenance of LED Light Sources including Addendum A

1.04 QUALITY ASSURANCE

- A. Luminaire and accessory components shall be constructed of materials appropriate for their use.
- B. Luminaires, drivers, other components shall meet the requirements of all applicable State and Municipal codes and energy codes.
- C. Provide luminaires listed and labeled by UL or other testing lab acceptable to local jurisdiction for their indicated use and installation conditions.
- D. Contractor shall coordinate installation of lighting systems with all trades.
 - 1. Manufacturers listed in the luminaire schedule shall be assumed capable of supplying listed luminaires. Any such exceptions shall immediately be brought to the attention of Architect and Engineer.

2. Multiple Name Specification:
 - a. When multiple manufacturers are listed, Electrical Contractor shall choose which of the listed products are to be provided.
 - b. Products of the same type shall be of same manufacturer.
 3. Single Name Specification:
 - a. When only one product is suitable for the application and/or no other known acceptable products exist, only one manufacturer/product is listed in the Luminaire Schedule. For such instances, Electrical Contractor shall provide the listed product with no exceptions.
 4. Contractor shall coordinate and verify compatibility of luminaires with lighting control system
 - a. Control protocol indicated for luminaires matches protocol of lighting control system specified. Contractor shall coordinate and verify compatibility of all dimming luminaires with control system to ensure that dimming is flicker free, continuous dimming through the dimming range noted on the luminaire schedule.
- E. Substitution requests:
1. Will be evaluated prior to Bid.
 2. Shall follow procedures set forth in this Section under paragraph 1.7 and in Section 01 2500 - Substitution Procedures.
 3. Shall be made not less than 10 days prior to bid date.
 4. Shall include the following information indicating that the proposed substitution is of similar construction quality and assembly, lumen output and distribution, color temperature, color consistency, and controllability:
 - a. Specified and proposed manufacturer's product data sheet, noting options and features.
 - b. Provide dimensioned drawing of luminaire.
 - c. Provide photometric data in form of an electronic IES file on USB or via email.
 5. Equipment delivery lead time shall not be held as a valid reason for requesting luminaire substitution unless luminaire lead time from specified manufacturer is in excess of 14 weeks. It shall be sole responsibility of Electrical Contractor to determine necessary equipment lead times, deliver submittals for review in a timely fashion, and place orders accordingly to ensure timely delivery.
 6. When requesting a substitution, Electrical Contractor shall provide unit and extended pricing for specified luminaire, unit and extended pricing for proposed alternate, and unit and extended delta savings to owner to be realized by accepting proposed alternate. If requested, provide unit pricing for each luminaire type specified to provide a baseline comparison for substitution request.
 7. Electrical Contractor shall guarantee pricing on all luminaire types for which a substitution request has been granted. This price guarantee shall be per unit and shall be maintained through the end of construction, regardless of quantity purchased.
 8. For all luminaire types using an LED light source, provide independently tested, IESNA LM79 compliant photometry testing data and IESNA LM-80 Lumen Maintenance data.

1.05 WARRANTY

- A. Exit Signs Utilizing LED Technology: Provide manufacturer's warranty for a period of not less than five years from the date of substantial completion including parts and labor for full replacement of defective product.
- B. LED Luminaires: Provide Manufacturer's warranty for a period of not less than five years from the date of substantial completion or the specified warranty period greater than five years for repair or replacement of defective electrical parts, including light source and driver.

- C. Luminaires without integral LED sources: Provide manufacturer's warranty for a period of not less than one year from the date of substantial completion including parts and labor for full replacement of defective product.

1.06 SUBMITTALS

- A. Electronic submittal format shall be limited to the greater of 500 pages or 30 MB to ensure that all pages load correctly. Bookmarks by luminaire type are required for ease of navigation. Submittals exceeding these limits should be broken in a logical fashion into multiple volumes for separate review. Measures to reduce file size should not compromise legibility or any other factors affecting ease of review.
- B. Upon award of Contract, submit complete list of lighting products to be furnished, with manufacturer and catalog designations, including current unit cost. Unit price shall be for equipment only and not include installation or miscellaneous electrical costs.
- C. Upon award of Contract, submit complete list of lighting products to be furnished, with manufacturer and catalog designations, including currently quoted lead times for product delivery. Should Electrical Contractor anticipate delivery schedule of any specified product may adversely impact construction schedule, they shall bring it to the attention of Owner/Architect at this time.
- D. In addition to complying with requirements of Section 26 0000 - General Electrical Requirements, submittals shall include the following:
 - 1. Manufacturer's product data
 - 2. Installation instructions
 - 3. Maintenance data
 - 4. Parts list for each luminaire accessory
 - 5. Photometric Data: photometric data for luminaire, including optical performance as follows:
 - a. Coefficients of utilization
 - b. Luminance table
 - c. Candela distribution data
 - d. Zonal lumens
 - e. Area and roadway luminaires shall include Isocandela Charts, IES Roadway Distribution Classification and IES BUG (Backlight – Uplight – Glare) ratings.
 - 6. Driver schedule indicating manufacturer, type, and catalog number for each luminaire
 - 7. Driver cut sheet for each driver used, referencing luminaire type(s)
 - 8. Product color/finish
 - a. Where specific finish or color is not specified and options exist, submit color or finish samples to Architect/Engineer for selection.
- E. Shop Drawings for equipment provided under this Section shall include the following:
 - 1. Overall submittal drawings indicating luminaire size, mounting (including ceiling type), light source, shielding, and voltage attributes, as well as manufacturer's product data, installation instructions, maintenance data, and parts list for each luminaire.
 - 2. Catalog cutsheets lacking sufficient detail will not be accepted.
 - 3. Detailed drawings of linear pendant mounted and suspended luminaires including dimensions, support spacing, suspension type, power feed type and locations, driver locations, wiring and controls configuration, luminaire joint locations and end plates. Provide canopy details that indicate coordination with the ceiling system provided.
 - 4. Detailed drawings for each cove and linear wall system configuration including dimensions, power feed locations, driver locations, luminaire joint locations, extension plates for end and corner sections and end plates.
 - a. LED strip luminaires mounted in architectural coves, provide dimensioned drawings and sections and include accessory cut sheets as specified. Within coves, all

luminaires are to be mounted end to end with no more than 12" unlit split evenly between ends

5. Detailed drawings for LED systems including LED color, color consistency, rated life, warranty, and scale plans with luminaire layout, number, type and location for drivers, and a complete bill of materials.
 6. Detailed drawings for continuous recessed or continuous surface mounted luminaires including dimensions, power feed locations, driver locations/quantity, luminaire joint locations, extension plates for end and corner sections and end plates as applicable.
 7. Detailed drawings for custom LED handrail systems including dimensions, power feed locations, driver locations/quantity, luminaire joint locations as applicable.
 8. Submit documentation that indicates specified products have been tested, or will be tested, for compatibility with the lighting controls being procured and will perform as specified. Control devices or system shall be able to control luminaires with flicker free, continuous dimming, in range specified. Electrical Contractor, luminaire manufacturer and lighting control manufacturer shall be financially responsible for any incompatibilities.
 9. Detailed drawings for nonstandard/custom luminaires indicating dimensions, weights, method of field assembly, components, features, and accessories. Details shall be scaled to a legible size.
 10. Detailed drawings for fiber optic systems including scaled plans with cable layout number and type of fiber bundles, illuminator quantity and location, and a complete bill of materials.
 11. Drawings for site lighting shall include pole data with wind loading, complete dimensions and finish, pertinent physical characteristics and accessories including mounting details, driver type and location and any specified control options.
 12. Photometric Data: Where indicated on luminaire schedule and Contract Drawings, supply complete photometric data for luminaire, including optical performance rendered by independent testing laboratory developed according to methods of the Illuminating Engineering Society of North America as follows:
 - a. Coefficients of utilization
 - b. Luminance table with data presented numerically, showing maximum luminaire luminance at shielding angles. Readings should be taken both crosswise and lengthwise in case of linear luminaire or luminaire with an asymmetric distribution.
 - c. Candela distribution data, presented graphically and numerically, in 5° increments (5°, 10°, 15°, etc.). Data developed for up and down quadrants normal, parallel, and at 11-1/2°, 45°, 67-1/2° to source if light output is asymmetric.
 - d. Zonal lumens stated numerically in 10° increments (5°, 15°, etc.) as above.
 13. No variation from the general arrangement and details indicated on drawings shall be made on shop drawings unless required by actual conditions. All variations shall be marked on drawings submitted for approval.
- F. Provide luminaires with factory or field finish as directed by Architect/Engineer. Verify final finish requirements before releasing luminaires for fabrication.
- G. Where specific finish or color is not specified and options exist, submit color or finish samples to Architect for selection. Luminaires not having color or finish acceptable to Architect shall be replaced at no additional cost.

1.07 SAMPLES

- A. Upon return of submittals, and prior to release for manufacturing, Contractor shall furnish one working sample of each luminaire for which sample requirement is noted in Luminaire Schedule.
1. All requested samples shall be furnished as specified on luminaire schedule including but not limited to: light output, correlated color temperature, distribution, lens type and finish EXCEPT sample shall be wired with minimum 6-ft cord and plug for energization at 120V.

- B. Shipping: Samples shall be complete with specified LED module(s), cord and plug, ready for hanging, energizing, and examining, and shall be shipped, prepaid by Contractor, to Architect/Engineer or as otherwise advised.
- C. Samples may not be returned, nor included in quantities listed for project.
- D. Sample must be actual working unit.
- E. All custom luminaires require a submission of material finish samples, component approval and a complete operating prototype luminaire. Prototype to be submitted prior to commencement of final luminaire fabrication and shall include specified LED modules. Modifications may be required as a result of prototype review. These modifications and others that do not materially affect the cost of the luminaire shall be incorporated at no additional cost to Owner.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Luminaires:
 - 1. As shown on Luminaire Schedule
- B. LED Drivers:
 - 1. Shall be manufacturer recommended compatible driver.
 - 2. All LED drivers shall be dimming type standard unless otherwise noted. Refer to construction documents for control per application.
 - 3. Manufacturers must be compatible with lighting control system(s) provided and control luminaires to specified minimum output per Luminaire Schedule and controls intent documents.
- C. Emergency LED Battery Pack:
 - 1. Bodine, Dual-Lite, Iota or as specified in the Luminaire Schedule
- D. Low Voltage Transformers:
 - 1. Q-Tran or as specified in the Luminaire Schedule
- E. LED Modules:
 - 1. Philips Lumileds, Xicato, Cree, GE, Nichia, Osram Sylvania, Bridgelux, Citizen or as specified in the Luminaire Schedule

2.02 FABRICATION AND MANUFACTURER

- A. Luminaires:
 - 1. Construction
 - a. Luminaires shall bear label indicating circuit voltage. Labels shall not be visible from normal viewing angles.
 - b. Luminaires shall be constructed with joints made by means of welded, brazed, screwed, or bolted construction methods.
 - c. Housings shall be so constructed that all electrical components are accessible and replaceable without removing luminaires from their mountings.
 - d. Surface temperatures of luminaires with integral drivers shall not exceed 90°C in 30°C ambient.
 - e. Luminaires recessed in ceilings utilized as air handling plenums shall be certified as suitable for the purpose and conform to NEC Article 300.
 - f. Miter cuts shall be accurate, joints shall be flush and without burrs.
 - g. Troffers with doors shall have spring-loaded door cam latches unless otherwise noted for special environments and applications.
 - h. Luminaires shall be free of light leaks and designed to provide sufficient ventilation of source to provide the photometric performance documented. Low voltage transformers and drivers shall be vented per manufacturer's specifications.
 - i. Provide inscription for exit and stairway signs to conform to applicable codes. Provide battery back-up as specified.

- j. Verify types of ceiling construction with General Contractor prior to releasing luminaires for fabrication and delivery and provide luminaires adapted to ceiling construction used.
 - k. Coordinate recessed luminaire mounting appurtenances, flanges and trims with construction of ceiling in which luminaire is to be recessed. Provide correct luminaire mounting assembly.
 - l. Luminaire frames shall be manufactured of non-ferrous metal or be painted after fabrication.
2. LED Luminaires are considered a lighting system with dependent components that must be evaluated as a complete system. Each LED luminaire includes a light emitting source, provisions for heat transfer, electrical control, optical control, mechanical support and protection, as well as aesthetic design elements. All LED luminaires shall:
- a. Be NRTL 3rd party tested to applicable UL standards. Where remote drivers are specified, all drivers shall also have UL listing or equivalent and comply with code requirements.
 - b. Be tested to IESNA LM-79-19 testing using absolute photometry criteria.
 - c. Be reported greater or equal to 70% lumen maintenance at 50,000 hours of operation.
 - d. Be rapid cycle stress tested.
 - e. Have integral LED modules with a minimum operating temperature of -20°C.
 - f. Have modules that are capable of being easily replaced upon failure with a manufacturer provided replacement module without voiding the UL listing of the luminaire.
 - g. Have driver housings easily accessible for ease of maintenance.
 - h. Have a maximum operating temperature at LED junction to not exceed 90°C over the expected operating range of the luminaire.
 - i. Be RoHS compliant, lead and mercury free.
 - j. Have an LED operating frequency of + or – 120 Hz.
 - k. Must meet the appropriate Federal Communications Commission (FCC) requirements for FCC 47 CFR 15 (consumer use) and/or FCC 47 CFR Part 18 (industrial use)
 - l. Be Class A Sound rated.
 - m. Be supplied with power supply that complies with IEEE C. 62.41-1991.
 - n. Operate at 120 or 277 volts, ±10%.
 - o. Have reverse polarity protected at all hardwired connections and have high voltage protection in the event connections are reversed or shorted during the installation process.
3. Lenses, Reflectors and Diffusers
- a. All lenses or louvers shall be removable but held so that normal motion will not cause them to drop out.
 - b. All glass used in luminaires shall be made from thermal shock resistant borosilicate glass.
 - c. Optical lenses shall be free from spherical and chromatic aberrations.
 - d. Acrylic lenses shall be 100% virgin acrylic material.
 - e. Diffuser materials shall be UV stabilized in applications exposed to sunlight.
 - f. Troffer lenses shall be 0.125" thick, unless otherwise noted.
 - g. Alzak reflectors and louvers shall be low iridescent equivalent to Coil Anodizers. All Alzak parabolic cones shall be guaranteed against discoloration for a minimum of ten years.
 - h. Reflector cones shall not have visible source flashing in the cone.

4. Optics and Adjustments
 - a. Adjustable Angle Luminaire: Luminaires with adjustment beam angle shall contain reliable angle locking devices.
5. Finishes
 - a. Provide luminaires with finish as shown in the luminaire schedule. Verify final finish requirements before releasing luminaires for fabrication.
 - b. Painted luminaires shall be painted after fabrication or "post painted".
 - c. Ferrous parts and supports shall be rust proofed after fabrication.
 - d. For weatherproof or vaportight installations, painted finishes of luminaires and accessories shall be weather resistant using proper primers or galvanized and bonderized epoxy, so that entire assembly is completely corrosion resistant for service intended and rated for an outdoor life expectancy of not less than 20 years.
6. Wiring
 - a. Luminaires shall be completely wired at the factory and as required by code.
 - b. Internal wiring shall contain no splices.
 - c. Connections shall be made with insulated "wire nut" type mechanical connectors except that driver connections shall comply with NEC Article 410.
 - d. Luminaires shall be provided with flexible conduit, pigtails, and equipment for external connections.
 - e. Recessed luminaires installed in inaccessible ceilings shall be UL listed for through wiring with the junction box accessible from the luminaire opening.
 - f. Cords shall be fitted with proper strain reliefs and watertight entries where required by application.
7. Ceiling Coordination
 - a. Verify type of ceiling construction prior to releasing luminaires for fabrication and delivery.
 - b. Provide mounting appurtenance, flanges, sloped ceiling adaptors where required.
 - c. Provide mounting assembly, clips or other mechanical mounting lugs as required for support of luminaires.
8. Track-Lighting Systems:
 - a. A lighting track system is defined as a manufactured assembly designed to support and energize luminaires that are capable of being readily repositioned on the track. Its length may be altered by addition or subtraction of sections of track. Lighting track may be either flexible or rigid depending on the specific application.
 - b. Provide lighting track types as specified in Luminaire Schedule, in lengths as indicated on lighting plans.
 - c. All line voltage track lighting systems shall be provided with integral current limiters or be fed from supplementary overcurrent protection panels to limit power consumed by track.
 - d. Lighting track system includes current carrying conductors which may convey either line voltages (120V or 277V) or low voltages (12V or 24V). Characteristics of lighting track that conveys line voltages are different than a lighting track system that conveys low voltages and as such are governed by different requirements. Therefore, they are considered individually in these Specifications.
 - 1) Line voltage (120V or 277V) Lighting Track systems:
 - a) Provide components, including track, fittings, and luminaires from the same manufacturer as recommended by manufacturer for the intended use. All components shall be UL Listed and comply with the National Electric Code Standards for Lighting Track.

- b) Maintain continuity of conductors through feeds, splice fittings and boxes. Relative positions of live and neutral conductors must always be maintained along continuous run so that track fittings connect into the track in a consistent manner.
 - c) Support lighting track at intervals recommended by the track manufacturer.
 - d) One or two circuit Lighting Track shall be supplied with separate neutral busbars and have the ability to have each circuit separately dimmed as required when using standard voltage and low voltage luminaires with either magnetic or electronic transformers.
 - e) Lighting Track shall have the ability to be dimmed or switched in selected sections in addition to dimming or switching an entire track configuration or track run.
 - f) One and two circuit 120 volt Lighting Track shall be rated at 120/250 volt, 60 Hz, 2,400 watts maximum each circuit. Neutral busbar(s) shall be oversized and comparable to #10 AWG 30 amp wire to reduce the possibility of overheating due to non-linear loads and harmonics.
 - g) One and two circuit 277 volt Lighting Track shall be rated at 277 volt, 50/60 Hz, 5,540 watts maximum each circuit. Neutral busbar(s) shall be oversized and comparable to #10 AWG 30 amp wire to reduce the possibility of overheating due to non-linear loads and harmonics.
 - h) A separate grounding busbar shall be integral in all track lengths.
 - i) 277 volt Track fittings shall be identified by a red rotor and a 277 volt label.
- 2) Low voltage (12V or 24V) Lighting Track systems:
- a) Provide components, including track conductors, remote mounted transformers, fittings, and luminaires from the same manufacturer as recommended by the manufacturer for the intended use. Components shall be UL Listed as applicable for low voltage use.
 - b) Maintain continuity of conductors through feeds, splice fittings and boxes. Relative positions of conductors must always be maintained along continuous run so that track fittings connect into track in a consistent manner.
 - c) Support lighting track at intervals recommended by track manufacturer.
 - d) One and two circuit low voltage Lighting Track shall be supplied with three conductors and have the ability to have each circuit separately switched with either magnetic or electronic transformers provided by the track manufacturer. Two circuit low voltage Lighting Track can only be dimmed if both circuits are fed from the same transformer and as a result, separate circuit dimming shall not be attempted or permitted.
 - e) All transformers shall be supplied with both primary and secondary voltage over-current protection devices that shall remain readily accessible for maintenance and testing purposes.
 - f) Lighting Track shall have the ability to be dimmed or switched in selected sections in addition to dimming or switching an entire track configuration or track run. Separate, single circuit transformers are required for each independently controlled circuit with the use of electrically isolated couplers.
 - g) Conductors used in low voltage Lighting Track shall be, at minimum, equivalent to #10 AWG 30 amp wire or heavier and be capable of carrying a 300 watt load (at 12 volts) up to 32 ft from transformer feed within range of luminaire voltage tolerance. At 24 volts, conductors shall be capable of supplying a 600 watt load up to 60 ft from transformer feed within range of luminaire voltage tolerance.

- h) If taut strung cable conductors are used as low voltage Lighting Track system, they shall have a Kevlar core to prevent strain on outer current carrying conductors.
 - i) Only insulated type taut strung cable conductors shall be used in order to comply with local electrical codes governing installation.
9. Outdoor Lighting Systems:
- a. Provide luminaires, mounting arms, brackets, poles, hand-hole covers, base components, and all other accessories for a complete assembly. Manufacturers shall be responsible for proper fitting of elements and structural integrity of unit
 - b. Provide poles as shown on luminaire schedule.
 - 1) Poles shall have hand-holes.
 - 2) Fusing for each luminaire head shall be located in hand-hole near base of pole.
 - 3) Pole base anchor bolts shall be galvanized.
 - c. Exterior Luminaires:
 - 1) Shall operate at a minimum ambient temperature of 0°F.
 - 2) Shall be fully gasketed, with UL wet location label.
 - 3) Shall have approved wire mesh screens for ventilation openings.
 - 4) Anodized aluminum reflectors shall have minimum of 0.00079" anodizing thickness.
 - d. Pole/Luminaire combination shall have EPA rating that will withstand site wind conditions.
 - e. All castings and extrusions shall be given minimum one coat of baked-on clear lacquer, unless painted finish is specified.
 - f. Aluminum surfaces shall receive a duronodic or polyester powder paint finish.
 - g. Cast-in Luminaire housings installed directly in concrete shall be fabricated of hot dip galvanized steel or cast aluminum or composite.
 - h. Where cast aluminum housings are used, give two coats of asphaltum paint prior to installation.
 - i. Provide 1/8" thick x 2" diameter solid neoprene grommets at each point light luminaire surfaces are mounted to concrete structure.

2.03 LED SOURCES

- A. Static white LED sources shall be:
 - 1. Minimum CRI of 85 unless noted otherwise on Luminaire Schedule
 - 2. Less than 5% flicker
 - 3. Within 0.004 on the CIE 1976 diagram for color spatial uniformity
 - 4. Within 0.007 on the CIE 1976 diagram for color maintenance over the rated lifetime of the source
 - 5. Binned within a 3-step MacAdam ellipse minimum, or as indicated in Luminaire Schedule
 - 6. Color temperature as noted on Luminaire Schedule
 - 7. Have a published life rating based on the point at which LED sources reach L70 lumen maintenance and tested in accordance with IES LM80-08 Approved Method: Testing Lumen Maintenance of LED light sources and IES TM-21-11: Projecting Long Term Lumen Maintenance of LED Light Sources
 - 8. L70 rated life shall be a minimum of 50,000 hours.
 - 9. LED modules, unless noted otherwise, shall be provided by light fixtures manufacturer and integral to luminaire.
 - 10. Screw-base LED replacement lamps, where required and listed on the luminaire schedule, shall meet dimming, output, CCT and CRI as specified. 25,000 hours is acceptable L70 rated life for these products.

2.04 DRIVERS

- A. Drivers for use in cold or freezer rooms, parking structures, loading docks, and outdoors shall be low temperature type.
 - 1. Driver shall have lowest temperature rating available in standard manufacture for its type.
- B. Drivers shall be located in luminaire they serve, unless otherwise noted.
- C. LED Drivers and Power Supplies shall:
 - 1. Operate system LEDs within the current limit specification of the LED manufacturer.
 - 2. Be supplied with over-temperature protection circuitry.
 - 3. Be within a NEMA enclosure.
 - 4. Be equipped with knockouts to accommodate standard conduit sizes
 - 5. Have a Power Factor to be = or > than 0.9
 - 6. Dimmable LED drivers must be compatible with dimming system(s) provided and control luminaires per luminaire schedule and controls documentation.
 - 7. ETL certified, CBM and UL Listed, high power factor, and meet or exceed NEMA and ANSI Standards.
 - 8. Class A sound rated
 - 9. Equipped with resetting thermal sensitive device.
 - 10. For operation at 60 Hz and voltage as scheduled.
 - 11. Meet or exceed all ANSI or NEMA standards
 - 12. Capable of operating LEDs with less than 5% flicker
- D. Emergency LED Drivers shall:
 - 1. Be UL 924 listed
 - 2. Operate LED luminaire at 10W minimum output for 90 minutes with efficacy equal to or greater than the normal power efficacy.
 - 3. Have high temperature nickel-cadmium battery.
 - 4. Be installed inside or on top of luminaires
 - 5. Have solid state charging
 - 6. Battery to be recharged within 24 h
 - 7. Automatic testing every 30 days for 30 seconds and once a year for 90 minutes. Provide with flashing indicator light and audible alarm.

2.05 LOW VOLTAGE TRANSFORMERS

- A. Transformers and power supplies shall be:
 - 1. Sized to compensate for voltage drop over indicated distances
 - 2. Locally fused
- B. Transformers shall have line voltage switch within reach.
- C. Provide adequate ventilation to meet code and manufacturers requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Marking:
 - 1. Voltage identification: Luminaires designed for voltages other than 110-125 volt circuits shall be clearly marked with rated voltage.
 - 2. Markings must be clear and shall be located to be readily visible to service personnel but invisible from normal viewing angles when luminaires are in place.
- B. Installation of Luminaires:
 - 1. Housing, glassware, reflectors and refractors shall be clean and free of chips, cracks and scratches.
 - 2. Install decorative luminaires, reflector cones, baffles, aperture plates, lenses, trims, and decorative elements of recessed luminaires after completion of ceiling tile, plastering, painting, and general cleanup is completed. Where luminaire location or construction does

not permit sequential installation, all reflectors, lenses, flanges and other visible surfaces shall be carefully protected.

3. Light leaks between ceiling trim of recessed luminaires and ceiling are not allowed.
4. Locations
 - a. Install luminaires at locations and heights as indicated.
 - b. Do not scale electrical drawings for locations of luminaires.
 - c. Architectural reflected ceiling plans show locations of luminaires.
 - d. Where noted on the drawings, the exact location of luminaires shall be confirmed (in the field) with the Architect/Engineer prior to installation.
 - e. Where luminaires are to be concealed, or surface mounted in highly visible public spaces, a small sampling of luminaires shall be installed, adjusted and aimed for Architect/Engineer's review approval, prior to installing remaining luminaire of same type.
 - f. Mount all luminaires so as to maintain full range of motion.
 - g. Install luminaires plumb, square, and level with ceilings and walls.
 - h. Coordinate stem, rod, chain, or aircraft cable hanger lengths with job conditions. Provide extra length of adjustable supports where diffusers are mounted directly above light fixtures to facilitate air balancing efforts.
 - i. Industrial type luminaires in unfinished areas, which are near obstructions such as ducts and pipes, shall be:
 - 1) Suspended so that bottom of luminaire is no higher than bottom of obstruction
 - 2) Located at height of lowest luminaire
 - 3) Minimum height: 8'-0"
 - 4) Shall not be located until locations of obstructions are determined.
 - 5) Where a minimum height of 8'-0" is unachievable, wall mounted luminaires will be utilized.
5. Support
 - a. Support surface mount luminaires from building structure.
 - b. Metal decking shall not be pierced for luminaire support.
 - c. Provide luminaires and/or luminaire outlet boxes with hangers to support luminaire weight.
 - d. Troffers shall be held in place by support clips.
 - e. Provide plaster frames for recessed luminaires in plaster ceilings.
 - f. Rigid metallic pipe stems shall be utilized for the support of pendant mounted luminaires, unless otherwise noted.
 - g. Stem hangers shall be equipped with aligner box covers or canopies so that stems hang vertically, irrespective of the angle of the surface they are mounted from.
 - h. Wherever a luminaire or its hanger canopy is attached to a surface mounted outlet box, a finishing ring shall conceal the outlet box.
 - i. Yokes, brackets and supplementary supporting members needed to mount luminaires to suitable ceiling members shall be furnished and installed by Contractor. Verify mounting hardware required prior to installation.
 - j. Recessed luminaires shall be supported with 12 ga wire hangers, 2 per luminaire, at diagonally opposite corners.
 - k. Troffers and luminaires over 55 lbs, such as 4' x 4' shall be supported with 12 ga wire hangers, 4 per luminaire, 2 at 45 degree diagonals, and two perpendicular to structure. Wire hangers and attachment to structure shall be capable of supporting 4 times luminaires weight.
 - l. In areas with seismic requirements, suspended or pendant mounted luminaires shall be able to swing 45 degrees in any direction without hitting an obstruction. In the event

- hitting an obstruction is unavoidable, guy wires will be used to secure the luminaire in place.
- m. Surface luminaires installed in grid ceilings shall be supported by independent support clips and 12 ga wire.
 - n. Exit signs installed in grid ceilings shall be supported by electrical box hanger and additional 12 ga wire installed from box to structure.
 - o. Support surface mounted luminaires greater than 2 ft in length at a minimum of each additional 2 ft, or as recommended by manufacturer.
 - p. Brace suspended luminaires installed near ducts or other constructions with solid pendants or threaded rods.
 - q. Rigidly align continuous rows of luminaires.
 - r. Luminaire types with remote mounted driver shall have:
 - 1) Proper support for driver weight.
 - 2) Mounting distance from remote driver to luminaire per manufacturer's recommendations.
6. Mounting and Enclosures
- a. Install flush mounted luminaires to eliminate light leakage.
 - b. For luminaires mounted adjacent to insulation, provide barrier to prevent insulation from coming in contact with luminaire, unless luminaire is approved for installation in contact with such insulation.
 - c. Provide approved fire rated enclosures around luminaires in fire rated ceilings.
7. Conduit and Wiring
- a. Wire for connections to modules and auxiliaries shall be suitable for temperature, current, and voltage conditions.
 - b. Recessed luminaires shall have final connections made with flexible metal conduit, not in excess of 72", with THHN conductors and green wire ground conductor.
 - c. Conduit shall be hidden from normal view in all possible cases. In public areas where surface mounted conduit must be used, contractor shall install conduit as unobtrusively as possible. Contractor shall obtain field approval by the architect for all exposed conduit runs prior to rough in.
8. In-Grade Luminaires:
- a. Where installed in tree grates, furnish burial light lens and louver to tree grate manufacturer for coordination of opening.
 - b. Provide adequate drainage system per manufacturer's recommendations.
- C. Installation of Outdoor Pole Bases
- 1. Contractor shall provide bases for luminaires.
 - 2. Provide handhole for electrical connection within 4'-0" of pole base.
 - 3. Contractor shall:
 - a. Rough-in conduits
 - b. Coordinate spacing, base dimensions, heights, orientation of bases, etc. as necessary.
 - 4. Where square or rectangular poles or luminaire heads are used, Contractor shall verify orientation with Architect/Engineer.
- D. Pole Installation:
- 1. Install luminaires, poles, hardware, etc., for complete system.
 - 2. Use web fabric slings (not chain or cable) to raise and set poles.
- E. Grounding:
- 1. Ground luminaires and metal poles according to Division 26 Section "Grounding and Bonding for Electrical Systems".
 - 2. Poles:

- a. Install 10 ft driven ground rod at each pole.
3. Nonmetallic Poles:
 - a. Ground metallic components of lighting unit and foundations. Connect luminaires to grounding system with #10 AWG conductor.

3.02 SUBSTANTIAL COMPLETION

- A. Quality Control:
 1. At Date of Substantial Completion, replace LED modules/LED luminaires which are not operating properly.
 2. Protection wrapping on lensed or louvered luminaires shall be removed before installation of furniture, but after finish work is complete.
 3. Deliver spare equipment to Owner's representative.
- B. Tests:
 1. Give advance notice of dates and times for field tests.
 2. Provide instruments to make and record test results.
 3. Verify normal operation of each luminaire after luminaires have been installed and circuits have been energized.
 4. Verify operation of luminaires with lighting control system and daylight harvesting systems. Any dimmed fixtures shall exhibit no signs of flickering.
 5. Replace or repair malfunctioning luminaires and components, then retest. Repeat procedure until all units operate properly.
 6. Report results of tests.
- C. Adjusting and Cleaning:
 1. Clean luminaires of handling marks, dust and dirt.
 2. Cleaning and touch-up work shall be performed in accordance with luminaire manufacturer's recommendations.
 3. Damaged luminaires or components shall be replaced with new.
 4. Keep luminaires clean and protected for remainder of construction period.
 5. Verify orientation of directional luminaires prior to installation.
 - a. This includes wall washers, cove lighting, floodlights, exterior area lights and adjustable accent luminaires. Contractor shall provide electrician's services to aim, adjust, and focus luminaires, as required, at direction of Architect/Engineer. These electricians shall be available at times designated by Architect/Engineer and shall be provided at no extra charge to Owner over base bid. Contractor shall provide equipment for luminaires' focus including ladders and mechanical lifting systems.
 6. Program preset dimming system lighting levels.
 7. Program ambient light sensors integral to luminaires for appropriate illumination levels as indicated in control narrative or in lighting control specifications.
 8. Program occupancy sensors integral luminaires for appropriate time delay as indicated in control narrative or in lighting control specifications.
 9. Exterior poles, bollards, bases and other exterior luminaires shall be painted to match factory color where finish has been damaged.
 10. No light leaks shall be permitted at ceiling line from any visible part or joint.
- D. Training
 1. Contractor shall provide Owner with 1 complete hardcopy and [1] digital copy of Operations and Maintenance manuals.
 - a. All "Approved as Noted" comments shall be corrected/picked-up in this record manual set.
 - b. Each manual shall contain specific information pertaining to the equipment installed. Each manual shall contain at a minimum:
 - 1) Detailed as built shop drawings for all lighting equipment installed.

- 2) Manufacturer's product cut sheets for all equipment installed keyed by type as to as built drawings.
 - 3) Manufacturer's complete installation instructions for all equipment installed keyed by type to as built drawings.
 - 4) Equipment maintenance requirements and schedules.
 - 5) Equipment manufacturer contacts.
 - 6) Equipment manufacturer warranties.
 - a) Luminaires
 - b) Drivers
 - c) LED modules
2. Contractor shall provide qualified personnel onsite to provide a minimum of one day of training to Owner's representatives.
 3. This training shall cover:
 - a. Luminaire use and maintenance
 - b. Architectural lighting system use and maintenance

END OF SECTION

SECTION 27 0000
GENERAL COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE

- A. This section details references, standards, guidelines, requirements and conditions common to all Division 27 work.
- B. Work under this Section and related sections is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.02 DESCRIPTION

- A. Intent of drawings and specifications is to obtain complete systems tested, adjusted, and ready for operation.
- B. Except as otherwise defined in greater detail, terms "provide", "furnish" and "install" as used in Division 27 contract documents shall have the following meanings:
 - 1. "Provide" or "provided" shall mean "furnish and install".
 - 2. "Furnish" or "furnished" does not include installation.
 - 3. "Install" or "installed" does not include furnishing.
- C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.
- D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.
- E. Included in this contract are connections to equipment provided by others. Refer to Architectural, Electrical, Integrated Automation, Mechanical, Security and final shop drawings for equipment being furnished under other sections for exact locations of outlets and various connections required.
- F. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions.
- G. Where architectural features govern location of work, refer to architectural drawings.
- H. Perform work in "neat and workmanlike" manner as defined in ANSI/NECA 1 "Standard Practices for Good Workmanship in Electrical Contracting".

1.03 RELATED WORK

- A. Related Division 27 Sections include:
 - 1. Section 27 0526 - Grounding and Bonding for Communications Systems
 - 2. Section 27 0528.29 - Hangers and Supports for Communications Systems
 - 3. Section 27 0528.33 - Raceway and Boxes for Communications Systems
 - 4. Section 27 0528.36 - Cable Tray for Communications Systems
 - 5. Section 27 0528.39 - Surface Raceways for Communications Systems
 - 6. [Section 27 0549 - Seismic Anchorage and Restraints]**
 - 7. Section 27 0553 - Communications Systems Identification
 - 8. Section 27 1000 - Structured Cabling
 - 9. Section 27 1100 - Communications Equipment Room Fittings
 - 10. Section 27 1300 - Communications Backbone Cabling
 - 11. Section 27 1500 - Communications Horizontal Cabling
 - 12. Section 27 1600 - Communication Connecting Cords, Devices and Adapters
 - 13. Section 27 5150 - Master Antenna Television Systems
 - 14. Section 27 5223 - Nurse Call System
- B. Related sections in other Divisions of Work:
 - 1. Section 26 0593 – Electrical Systems Firestopping

2. Also refer to individual technical sections identified above.
- C. Utility Services:
 1. **[Revise to include Telecom Utility language.]**
- D. Temporary Services:
 1. Refer to Division 01 - Temporary Facilities and Controls.
 2. **[Other]**
- E. Continuity of Service:
 1. No service shall be interrupted or changed without permission from Architect and Owner. Obtain written permission before work is started.
 2. When interruption of services is required, persons concerned shall be notified and shall agree upon a time.
- F. Demolition:
 1. Division 01 - Selective Demolition.
 - a. Not applicable to this Division of work.
 2. Division 02 - Building Demolition
 - a. Not applicable to this Division of work.
 3. Perform demolition as required to accomplish new work.
 - a. Remove abandoned wiring to source of supply.
 - b. Disconnect abandoned outlets and remove devices.
 - c. Remove abandoned outlets if conduit servicing them is abandoned and removed.
 - d. Provide blank cover for abandoned outlets that are not removed.
 - e. Disconnect communications systems in walls, floors, and ceilings scheduled for removal.
 4. Accomplish work in neat workmanlike manner to minimize interference; annoyance or inconvenience such work might impose on Owner or other contractors.
 5. Unless otherwise noted, remove from premises materials and equipment removed in demolition work.
 6. Equipment noted to be removed and turned over to Owner shall be delivered to Owner at place and time Owner designates.
 7. Where materials are to be turned over to Owner or reused and installed by Contractor, it shall be Contractor's responsibility to maintain condition of materials and equipment equal to that existing before work began. Repair or replace damaged materials or equipment at no additional cost to Owner.
 8. Where demolition work interferes with Owner's use of premises, schedule work through Architect, Owner and with other contractors to minimize inconvenience to Owner. Architect must approve schedule before Contractor begins such work.
- G. Cleaning and Repair
 1. Clean and repair existing materials and equipment that remain or will be reused.
- H. Concrete Work:
 1. Provide cast-in-place concrete as required by contract documents unless otherwise noted.
 2. Concrete shall comply with Division 03 - Concrete.
 3. Provide anchor bolts, metal shapes and templates required to be cast in concrete or used to form concrete for support of equipment.
- I. Painting:
 1. Furnish equipment with factory applied prime finish unless otherwise specified.
 2. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Engineer.
 3. Furnish one can of touch up paint for each factory finish, which will be final finished surface of product.

4. **[Owner][Contractor]** is responsible for painting of plywood in Telecommunications Equipment Rooms. Refer to Drawings.

1.04 REQUIREMENTS OF REGULATORY AGENCIES

- A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of contract shall become part of this specification.

1.05 REFERENCES AND STANDARDS

- A. Design, cable and component selection, and installation practices shall conform with following:
 1. ANSI/NFPA 70 - National Electrical Code
 2. Local Electrical Code
 3. Country, state and local health, safety and building codes
 4. UL 444 - Communications Cables
 5. Standards identified in individual Technical Sections.
 6. BICSI Telecommunications Distribution Methods Manual (TDMM)
 7. TIA 568.0-D through.4-D - Commercial Building Telecommunications Cabling Standard (including applicable Addenda)
 8. TIA 569-E - Commercial Building Standard for Telecommunications Pathways and Spaces
 9. **[OTHER]**

- B. Agencies or publications referenced herein refer to the following:

1. ANSI American National Standards Institute
2. ASME American Society of Mechanical Engineers
3. ASTM American Society for Testing and Materials
4. BICSI Building Industry Consulting Services International
5. FIPS Federal Information Processing Standards
6. FCC Federal Communications Commission
7. ICEA Insulated Cable Engineers Association
8. IEEE Institute of Electrical and Electronics Engineers
9. NEC National Electrical Code
10. NECA National Electrical Contractors Association
11. NEMA National Electrical Manufacturers Association
12. NESC National Electrical Safety Code
13. NETA National Electrical Testing Association
14. NFPA National Fire Protection Association
15. NIST National Institute of Standards and Technology
16. OSHA Occupational Safety and Health Administration
17. TIA Telecommunications Industry Association
18. UL Underwriters Laboratories, Inc.

- C. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.06 DEFINITIONS

- A. The following definitions are applicable to communications environments and shall apply to this document and its companion sections for clarification and direction.
 1. Entrance facility - an entrance to building for both public and private network service cables and/or wireless services including entrance point of building and continuing to Entrance Room.
 2. Entrance Room - room where both public and private network service cables and/or wireless services are terminated. Service provider(s) point-of-demarkation (DEMARC) is typically located here.
 3. Equipment Room (Telecom): an environmentally controlled centralized space for telecommunications equipment that usually houses main or intermediate cross-connect.

Backbone cabling, cabling to Building Entrance and horizontal cabling may be terminated here.

4. **[Equipment Intermediate Distribution Facility – Centralized space for security, building automation, fire alarm and/or other low-voltage equipment. (An AEI-term).]**
 5. Guarantee - promise or an assurance that attests to quality or durability of product or service or that task will be performed in specified manner. Used interchangeably with "Warranty" in these documents.
 6. Intra-building - within single building.
 7. Inter-building - between 2 or more buildings.
 8. IP Telephony – Use of [Internet Protocol \(IP\)](#) for two-way transmission of conversations. Sometimes referred to as "Voice over Internet Protocol (VoIP)".
 9. Rack Unit - standard measurement of vertical mounting space on an equipment rack. Each Rack Unit is 1-3/4" high.
 10. Voice over Internet Protocol – Refer to IP Telephony.
- B. Typical NEMA Enclosures and Usage
1. Refer to Section 26 0000 – General Electrical Requirements.
 1. **[NEMA 1 - Indoors. Falling dirt**
 2. **NEMA 2 - Indoors. Falling dirt. Falling liquids. Light splashing**
 3. **NEMA 3 - Outdoors. Sleet, snow, rain. Windblown dust**
 4. **NEMA 3X - Same as NEMA 3 plus corrosion resistant**
 5. **NEMA 3S - Same as NEMA 3 plus mechanism operable when ice covered**
 6. **NEMA 3SX - Same as NEMA 3S plus corrosion resistant**
 7. **NEMA 3R - Outdoors. Rain, snow, sleet**
 8. **NEMA 3RX - Same as NEMA 3R plus corrosion resistant**
 9. **NEMA 4:**
 - a. **Indoors - Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down**
 - b. **Outdoors - Rain, sleet, snow. Wind blown dust. Hose down**
 10. **NEMA 4X - Same as NEMA 4 plus corrosion resistant**
 11. **NEMA 5 - Indoors. Falling Dirt. Falling Liquids. Settling dust, lint and fibers**
 12. **NEMA 6:**
 - a. **Indoors - Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down. Temporary submersion.**
 - b. **Outdoors - Rain, snow, sleet. Windblown dust. Hose down. Temporary submersion.**
 13. **NEMA 6P:**
 - a. **Indoors - Same as NEMA 6 / Indoors plus corrosion resistant. Prolonged submersion.**
 - b. **Outdoors - NEMA 6 /Outdoors plus corrosion resistant. Prolonged Submersion.**
 14. **NEMA 7 - Indoors. Class I, Division 1 or 2, Groups A, B, C or D. (Flammable gas).**
 15. **NEMA 9 - Indoors. Class II, Division 1 or 2. Groups E, R, or G. (Combustible dust).**
 16. **NEMA 12 - Indoors. Falling Dirt. Falling liquids. Flying dust, lint and fibers. Oil or coolant seepage.**
 17. **NEMA 13 - Same as NEMA 12 plus oil or coolant spraying or splashing.]**

1.07 ABBREVIATIONS AND ACRONYMS

- A. The following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction.
1. AFF Above Finished Floor
 2. ATM Asynchronous Transfer Mode
 3. AWG American Wire Gauge

4. BAS Building Automation Systems
5. BTU British Thermal Unit
6. CATV Community Antenna Television
7. CCTV Closed-Circuit Television
8. CDDI Copper Distributed Data Interface (Cisco Systems trade name for TP-PMD)
9. cm centimeters
10. °C degrees Celsius
11. °F degrees Fahrenheit
12. DTMF Dual Tone Multi Frequency
13. EIA Electronic Industries Alliance
14. EF Entrance Facility
15. ER Entrance Room
16. EIDF Equipment Intermediate Distribution Facility
17. FDDI Fiber Distributed Data Interface
18. ft feet
19. GbE Gigabit Ethernet
20. Hz Frequency in Hertz (k = kilo, M = Mega, G = Giga)
21. ID Inside Diameter
22. ininch
23. IPT IP Telephony
24. kg kilogram
25. lbs pounds
26. LAN Local Area Network
27. MATV Master Antenna Television
28. MC Main Cross-connect
29. mmeters
30. mm millimeters
31. Mbps Megabits per second
32. μm micrometer (10⁻⁶ meter)
33. OD Outside Diameter
34. PBX Private Branch Exchange (Telephone Switch)
35. pF pico-Farad (10⁻¹² Farad)
36. PVC Polyvinyl Chloride
37. RU Rack Unit
38. sq ft square feet (area)
39. TP-PMD Twisted Pair Physical Medium Dependent
40. WAN Wide Area Network
41. WLAN Wireless Local Area Network
42. VoIP Voice over Internet Protocol

B. Refer also to technical sections for additional terminology.

1.08 LISTING

A. Refer to technical sections of this Division of work for listing requirements.

1.09 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section:

1. Refer to Division 01 - Submittal Procedures.
2. Note that for satisfying submittal requirements for Division 27, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, expression "Shop Drawings" is generally used throughout specification.
3. Mark catalog sheets and drawings to indicate specific items submitted.
 - a. Markings shall be reproducible (e.g. arrow, boxed, encircled, checkmark).

- b. Where sheet includes multiple product options, mark proposed option(s).
 4. Include proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
 5. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Mark and annotate submittals accordingly.
 6. Group submittals by Section to include complete documentation of related systems, products and accessories. Where applicable, dimensions shall be marked in units to match those specified.
 7. Submittals shall be in electronic form or on paper per Division 01.
 - a. Documents in electronic form shall be *ADOBE Acrobat* PDF.
 - b. Paper documents shall be original catalog sheets or photocopies thereof.
 - c. Facsimile (fax) sheets will not be accepted.
 8. Engineer's Review is to confirm compliance with performance, interoperability, physical, and other pertinent requirements of project. Review is not to confirm quantities nor that all required items have been submitted.
 9. When equipment and items specified include accessories, parts and additional items under one designation, submittals shall be complete and include required components.
 10. Include wiring diagrams for electrically powered or controlled equipment.
 11. Submit equipment room layouts drawn to scale, including equipment, raceways, accessories and clearance for maintenance.
 12. Where submittals cover products containing potentially hazardous non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
 13. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
 14. Submittals, which are not complete, not permanent, or not properly checked by Contractor, will be returned without review.
 15. "Coordination Drawings", which are normally prepared by Contractor to coordinate work among various trades and to facilitate installation, shall not be submitted for Division 27 work unless specifically requested in technical sections. These types of drawings typically include dimensioned piping, ductwork, communications and/or electrical raceway layouts.
 - a. Unless specifically requested in Division 27 technical sections, submittals of coordination drawings will be returned without review.
- B. Certificates and Inspections:
1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.
- C. Operation and Maintenance Manuals:
1. Refer to Division 01 - Operation and Maintenance Data.
 2. Upon completion of work but before final acceptance of system, submit to Architect for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy" is larger than 2" thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.
 3. Manuals shall be organized by specification section number and shall have table of contents and tabs for each piece of equipment or system.
 4. Manuals shall include the following:
 - a. Copies of shop drawings
 - b. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment. Where manufacturer's data includes several types or models, applicable type or model shall be designated.
 - c. CD ROM's of O&M data with exploded parts lists where available

- d. Phone numbers and addresses of local parts suppliers and service companies
 - e. Internet/WEB page addresses where applicable
 - f. Wiring diagrams
 - g. Start up and shut down procedure
 - h. Factory and field test records
 - i. Additional information, diagrams or explanations as designated under respective equipment or systems specification section
5. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
6. O&M manuals and instructions to Owner shall be provided prior to request for final payment.
- D. Record Documents:
1. Refer to General Conditions of Contract, and Division 01 - Closeout Procedures. Prepare complete set of record drawings in accordance with Division 01.
 2. Use designated set of prints of contract documents as prepared by Architect to mark-up for record drawing purposes.

1.010 JOB CONDITIONS

- A. Building Access:
1. Arrange for necessary openings in building to allow for admittance of all apparatus.
- B. Cutting and Patching:
1. Refer to General Conditions of Contract, and Division 01 - Cutting and Patching.
 2. Perform cutting and patching required for complete installation of systems unless otherwise noted. Patch and restore work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.
 3. Provide materials required for patching unless otherwise noted.
 4. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
 5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.
- C. Housekeeping and Cleanup:
1. Refer to Division 01 - Closeout Procedures.
 2. Periodically as work progresses and/or as directed by Architect, remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.011 WORK BY OWNER

- A. Owner will provide:
1. **[Active electronics for interface with building voice and data cabling systems]**
 2. **[Connections from telephone and data equipment to Contractor provided cabling]**
 3. **[Connections from Backbone Voice Cables to Horizontal Voice Cables]**
 4. **[Passive Broadband distribution hardware (coaxial cable taps and splitters)]**
 5. **[Active Broadband headend and distribution hardware (e.g. video processing, distribution amplifiers)]**
 6. **[Equipment Racks and/or Cabinets]**
 7. **[XXX]**

1.012 QUALITY ASSURANCE

- A. Refer to the individual technical sections for general product quality requirements, manufacturer qualifications, and contractor qualifications and certification requirements.

B. [OTHER]

1.013 GUARANTEE

- A. Refer to Division 01 for general Guarantee (Warranty) requirements.
- B. Refer to technical sections for Guarantee requirement for each system.
 - 1. Where no guarantee requirements are called out, guarantee **[as called out in Division 01]** **[for one year after acceptance by Owner]** equipment, materials, and workmanship to be free from defect.
- C. Repair, replace or alter systems or parts of systems found defective at no extra cost to Owner.
- D. Wherein fulfilling requirements of any guarantee, if Contractor disturbs any work guaranteed under another contract, restore such disturbed work to condition satisfactory to Architect and guarantee such restored work to same extent as it was guaranteed under such other contract.
- E. Guarantees shall include labor, material and travel time.

PART 2 - PRODUCTS

2.01 PRODUCT SUBSTITUTIONS

- A. Refer to Division 01 - Product Requirements.

PART 3 - EXECUTION

3.01 GENERAL

- A. Verify elevations and measurements prior to installation of materials.

3.02 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01.
- B. Store and protect products under provisions of Division 01.
- C. Store in clean, dry space.
- D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.
- E. Handle in accordance with manufacturer's written instructions.
- F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

3.03 FLOOR, WALL, ROOF AND CEILING OPENINGS

- A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide during progress of construction sleeves and inserts that are to be built into structure.
- B. Temporary sleeves, if used to form wall openings, shall be removed prior to installation of permanent materials. Permanent sleeves for wall penetrations shall be minimum 24 ga galvanized sheet metal unless otherwise noted.
- C. Steel sleeves, when required, shall be Schedule 40 carbon steel pipe with integral water stop.
- D. For core drilled holes, size and location shall be reviewed and approved by Structural Engineer prior to execution.
- E. Submit product data and installation details for penetrations of building structure. Submittal shall include schedule indicating penetrating materials, (including steel conduit, PVC conduit, cables, cable tray), sizes of each, opening sizes and sealant products intended for use.
- F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Division 26.
- G. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Drawings shall be approved by the structural engineer prior to preparing openings in structural member.
- H. Openings for penetrations shall be minimum 1/2" larger on all sides than outside dimensions of raceways or cables. However, where fire resistant penetrations are required, size openings in accordance with recommendations of firestopping systems manufacturer.

- I. Seal non fire-rated floor penetrations with non-shrink grout equal to Embecco by Master Builders, or urethane caulk, as appropriate.
- J. Seal non-rated wall openings with urethane caulk.
- K. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation, or sealing system by another manufacturer approved as equal by Architect. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.
- L. Finish and trim penetrations as shown on details and as specified hereinafter.
- M. Provide chrome or nickel plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor's closets, storage rooms, etc., unless suspended ceilings are specified.
- N. In **[GMP clean room] [Bio-safety] [Vivarium] [other]** areas, penetrations shall be sealed.
 - 1. Provide gasketed device cover plates with an additional continuous bead of silicone caulk between device plate and adjacent wall, ceiling or floor surface.
 - 2. Once wiring is installed, surround wiring with 1" barrier of silicone caulking around conductors within device box hub.
 - 3. Caulk shall be resistant to microbiological growth.

3.04 EQUIPMENT ACCESS

- A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocation of raceways, or accessories as required to provide access, shall be provided at no additional cost to Owner.
- B. Install equipment with ample space allowed for removal, repair or changes to equipment. Provide ready accessibility to equipment and wiring without moving other equipment, which is to be installed or which is already in place.
- C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors shall be for purpose of providing access where equipment requiring servicing, repairs or maintenance is located in walls, chases or above inaccessible ceilings.
- D. Provide necessary coordination and information to Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes and rough-in dimensions, without limitations.
- E. Provide access doors where equipment, requiring access for servicing, repairs and maintenance is located in walls, chases or above inaccessible ceilings, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Access doors used in fire-rated construction shall have UL label. Access doors shall be steel, prime coated, except use stainless steel doors in ceramic tile walls, toilet rooms, locker rooms, and in areas subject to excessive moisture. Access doors shall be of sufficient size to allow for total maintenance. Location of access doors shall be coordinated with General Contractor and location of equipment shall be roughed in accordingly.
- F. Locate communications outlets and equipment to fit details, panels, decorating or finish at space. Architect reserves right to make minor position changes of outlet locations before work has been installed.
- G. Verify room door swings before installing wall-mounted communications outlets and install boxes on latch side of door unless otherwise noted.

3.05 EQUIPMENT SUPPORTS

- A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers.

- B. Concrete anchors, used for attachment to concrete, shall be steel shell with plug type. Plastic, rawhide or anchors utilizing lead are not allowed.
- C. Do not support equipment or cable pathways from metal roof decking.

3.06 SUPPORT PROTECTION

- A. In occupied areas, mechanical rooms and areas requiring normal maintenance access, certain equipment must be guarded to protect personnel from injury.
- B. Provide minimum 1/2" thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.
- C. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

3.07 CABLE PROTECTION

- A. Protect cabling and termination components from contact with, and potential application of, foreign materials.
 - 1. Foreign material is defined as material that is not part of cabling assembly and termination components when delivered from manufacturer.
 - 2. Examples include paint overspray and drywall compound.
- B. Cabling and components that come into contact with foreign materials shall be replaced at no cost to project.
 - 1. Solvents and other cleaning agents shall not be used to remove foreign materials that have already accumulated on cabling and components.

3.08 HOUSEKEEPING PADS

- A. Not applicable to this Division of work.

3.09 LEAD SHIELDING

- A. Wherever installation of this Contractor's equipment destroys radiological integrity of wall, floor, or ceiling, this Contractor shall be responsible to provide suitable lead shielding to maintain that integrity. Coordinate these requirements with General Contractor.

3.010 ACCEPTANCE TESTING

- A. Prior to testing, submit to owner (or Owner's representative) and Engineer, proposed schedule for acceptance testing.
 - 1. This notification shall be minimum of **[10] [XXX]** working days in advance to allow for participation by Owner and/or Engineer.
- B. Prior to testing, submit written description of intended test procedures and submit sample test forms to Engineer.
 - 1. Submitted information shall include proposed file naming format to be used in identifying cable, pair or optical fiber which is subject of test record.
 - 2. Failure to provide above information shall be grounds for Engineer or Owner to reject any Documentation of related testing and to require repeat of affected test.
- C. Conduct tests during course of construction when identifiable portion(s) of installation is complete.
 - 1. Alternatively, testing can be conducted after entire installation is complete if this does not delay project schedule.
- D. Provide equipment and personnel necessary to conduct acceptance tests.
- E. Testing shall be completed and accepted by Owner and Engineer before Owner furnished equipment and cross connects are installed.
- F. Document tests.

- G. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or materials as necessary and repeat inspection and test. This shall be at no additional cost to the owner. Replacement materials shall be new.
- H. This Contractor is responsible for certifying, in writing, equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria and name and title of person signing test certification documents.
- I. Maintain copies of certified test results, including those for failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

3.011 START-UP

- A. Systems and equipment shall be started, tested, adjusted and turned over to Owner ready for operation.
 - 1. This includes "Owner-Furnished, Contractor-Installed" (OFICI) and "Contractor-Furnished, Contractor-Installed" (CFICI) systems and equipment.
- B. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.
- C. Contractor shall provide services of technician/installer knowledgeable in start-up and checkout of types of systems and equipment on project.
- D. Provide start-up services, by manufacturer's representative where specified or where Contractor does not have qualified personnel.
- E. Coordinate start-up with trades.

3.012 DOCUMENTATION

- A. Upon completion of installation, Contractor shall provide System Documentation. Documentation shall include:
 - 1. Acceptance Test Results
 - 2. Record Drawings
 - 3. All Approved Submittals
 - 4. Manufacturer's Warranty Documents
- B. Submit System Documentation in accordance with Division 01 "Project Record Documents".
 - 1. Documents shall be submitted in same electronic format in which they were received from Architect and Engineer.
 - 2. Document updates shall be performed in native software format matching original design team documents.
 - a. Scans of hand marked documents shall not be allowed.
 - 3. Update documents to reflect installed conditions for equipment shown on documents.
- C. Submit documentation within ten (10) working days of the completion of testing of each testing phase (e.g. subsystem, cable type, area, floor) or 3 weeks prior to scheduled occupancy of subject area, whichever is sooner. This is inclusive of Test Result and draft Record Drawings.
 - 1. Draft drawings may include mark-ups done by hand.
 - 2. Machine generated (final) copies of Record Drawings shall be submitted within 30 working days of completion of each testing phase.
 - 3. Documentation will include all aspects of systems covered by these specifications that are required for systems to be fully functional.
 - 4. For structured cabling this includes the horizontal link from the TO to the HC, backbone cabling from the HC to the MC, cross-connections, interconnections and/or patch cords that are the responsibility of the contractor.
- D. Submit Acceptance Test Results in electronic form for review and distribution.
 - 1. Interim documentation of Test Results (if applicable) may be submitted via email or on CD-ROM.
 - 2. Final documentation of Test Results shall be submitted on CD-ROM.

3. Test results shall be submitted in format(s) native to test instrument(s) used in performing testing.
4. Where unique software (other than an MS-Word™ compatible Word Processor or MS-Excel™ spreadsheet) is required for viewing of test results, Contractor shall provide along with above documentation, **[quantity]** licensed copy of such software. Software shall run on MICROSOFT Windows-based personal computer.
- E. Acceptance Test results shall include description of sub-system tested, equipment/cable/outlet I.D., reference and test setup, test equipment type/model and serial number(s), equipment location and direction of test (if applicable), test frequencies/wavelengths, date and operator name(s).
- F. Engineer or Owner may request that 10% random re-test be conducted on cable system - at no additional cost - to verify documented findings. Tests shall be a repeat of those defined above and in technical sections.
 1. Owner may also perform independent testing to verify results.
 2. If findings contradict documentation submitted by Contractor, additional testing can be requested to extent determined necessary by Engineer or Owner, including 100% re-test. This re-test shall be at no additional cost to Owner.
- G. Documentation - including hard copy and electronic forms of Test Data and Record Drawings - shall become property of Owner.
- H. Refer also to Technical Sections for requirements specific to covered subsystems.

3.013 CLEANING

- A. After installation is complete, Contractor shall clean all systems.
- B. Vacuum debris from system components, enclosures, junction boxes and pull boxes prior to testing and again prior to completion.
- C. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

END OF SECTION

Note:

The following is provided as an aid in understanding overall submittal requirements for Division 27 sections. Some sections and/or items may not apply. Contractor is responsible for submitting product data for all pertinent items specified in Division 27 Technical Sections include in project.

27 0000 - General Communications Requirements

None Required

27 0526 - Grounding and Bonding for Communications Systems

Telecom Main Ground Busbar (TMGB)	Division 26 Submittals
Telecom Ground Busbar (TGB)	Division 26 Submittals
Telecom Bonding Backbone (TBB)	Division 26 Submittals
Telecom Grounding Equalizer (GE)	Division 26 Submittals
Connector – Mechanical Type	Division 26 Submittals
Connector - Compression Type	Division 26 Submittals

27 0528.29 - Hangers and Supports for Communications Systems

J-Type Cable Supports

27 0528.33 - Raceway and Boxes for Communications Systems

Optical Fiber Cable Raceway (Innerduct)	
Multi-cell Fabric	
Outlet Box for Flush-Mount Locations	Division 26 Submittals
Pull/Junction Boxes	Division 26 Submittals
Indoor Service Pole	Division 26 Submittals
Floor Box	Division 26 Submittals
Poke-thru Assembly	Division 26 Submittals
Surface Raceway / Individual Outlet Locations	Division 26 Submittals
Surface Raceway / Divided / Multiple Outlets	Division 26 Submittals
Raceway Device Cover	Division 26 Submittals

27 0528.36 – Cable Tray for Communications Systems

Aluminum Ladder-type Tray	Division 26 Submittals
Barrier Strips	Division 26 Submittals
Tray Cover	Division 26 Submittals
Tray Supports	Division 26 Submittals
Cable Tray Dropout	

27 0553 - Communications Systems Identification

Equipment Room
Equipment Rack
Telecommunications Outlet
Horizontal Cable
Modular Patch Panels
Backbone Copper Cable
Termination Blocks
Backbone Fiber Optic Cable
Fiber Optic Patch Panels
Innerduct
Telecommunications Grounds

27 1000 - Structured Cabling

Contractor Certification / Warranty
Statement
Test Procedure(s) & Sample Results

27 1100 - Communications Equipment Room Fittings

Equipment Rack / Floor-standing
Equipment Rack / Wall-mount
Equipment Cabinet
Cable Management – Vertical
Cable Management - Horizontal
Equipment Rack Ground Busbar
Cable Runway
Cable Runway Cable Dropout
Termination Blocks
Wire Mgmt for Blocks (Horizontal)
Wire Mgmt for Blocks (Vertical)
Modular Patch Panels
Fiber Optic Patch Panels
Fiber Optic Splice Enclosure
Fiber Optic Coupling (F/F); multimode
Fiber Optic Coupling (F/F); single-
mode
Fiber Optic Slack Storage Box
Entrance Protection Housing
Protector Module
Power Strip / Surge Suppressor
Cable Support Ties (Releasable)

27 1300 - Communications Backbone Cabling

Twisted-Pair Cable
Coaxial Cable
Fiber Optic Cable
Coax Connector
Fiber Optic Connector; multimode
Fiber Optic Connector; single-mode

27 1500 - Communications Horizontal Cabling

4-Pair Horizontal Copper Cable
Horizontal Coaxial Cable
Horizontal Fiber Optic Cable
Telecommunications Outlet – Workstation
Telecommunications Outlet – Wall-Mount Phone
Telecommunications Outlet – Wireless AP
Telecommunications Outlet – Surface Raceway
Telecommunications Outlet – Modular Furniture
Telecommunications Outlet – Industrial
Modular Jack
Coaxial Connector (Male)
Coaxial Connector Coupling (F/F)
Fiber Optic Connector (Male); multimode
Fiber Optic Connector (Male); single-mode
Fiber Optic Coupling (F/F); multimode
Fiber Optic Coupling (F/F); single-mode

27 1600 - Communications Connecting Cords Devices and Adapters

4-pair Modular Patch Cords
Modular-to-110 Patch Cords
Industrial 4-pair modular Patch Cords
Fiber Optic Patch Cords / Multimode
Fiber Optic Patch Cords / Single-mode
Coaxial Patch Cords

END

SECTION 27 0526
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

- A. This section includes product and execution requirements for Grounding and Bonding that are unique to communications systems and not included in Division 26 sections.

1.02 DESCRIPTION

- A. Grounding and Bonding infrastructure for communications includes Cabling, Busbars and Connectors.

1.03 RELATED WORK

- A. Related Division 27 Sections include:
1. Section 27 0000 - General Communications Requirements
 2. Section 27 0528.33 - Raceway and Boxes for Communications Systems
 3. Section 27 0528.36 - Cable Tray for Communications Systems
 4. Section 27 0528.39 - Surface Raceways for Communications Systems
 5. Section 27 0553 - Communications Systems Identification
 6. Section 27 1000 - Structured Cabling
 7. Section 27 1100 - Communications Equipment Room Fittings
 8. Section 27 1300 - Communications Backbone Cabling
 9. Section 27 1500 - Communications Horizontal Cabling
 10. Section 27 5150 - Master Antenna Television Systems
 11. Section 27 5223 - Nurse Call System
- B. Related sections in other Divisions of Work:
1. Section 26 0526 - Grounding and Bonding for Electrical Systems

1.04 REFERENCES AND STANDARDS

- A. Refer to Section 27 0000 - General Communications Requirements which identifies pertinent References and Standards.
- B. In addition, the following apply:
1. IEEE/ANSI 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 2. IEEE 837 - Standard for Qualifying Permanent Connections Used in Substation Grounding.
 3. UL 467 Electrical Grounding and Bonding Equipment
 4. ANSI J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 5. ANSI J-STD-607-D - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

1.05 DEFINITIONS

- A. Refer to Section 27 0000 - General Communications Requirements which provides information on Definitions used in this and related sections.
- B. Additional definitions (per referenced standards):
1. Telecommunications Main Grounding Busbar: Busbar placed in convenient and accessible location and bonded by means of bonding conductor for telecommunications to building service equipment (power) ground.
 2. Telecommunications Grounding Busbar: Interface to building telecommunications grounding system generally located in telecommunications room. Common point of connection for telecommunications system and equipment bonding to ground, and located in telecommunications room or equipment room.

3. Telecommunications Bonding Conductor: Conductor that interconnects telecommunications bonding infrastructure to building's service equipment (power) ground.
4. Telecommunications Bonding Backbone: Conductor that interconnects telecommunications main grounding busbar to telecommunications grounding busbar.
5. Grounding Equalizer: Conductor that interconnects elements of telecommunications grounding infrastructure.
6. Exothermic Weld: Method of permanently bonding two metals together by controlled heat reaction resulting in molecular bond.
7. Irreversible Compression: Permanent mechanical bond between conductors or conductor and connector using mechanical or hydraulic tool.

1.06 ABBREVIATIONS AND ACRONYMS

- A. Refer to Section 27 0000 - General Communications Requirements which provides information on Abbreviations and Acronyms used in this and related sections.
- B. Additional abbreviations and acronyms (per referenced standards):
 1. Telecommunications Main Grounding Busbar - TMGB
 2. Telecommunications Grounding Busbar - TGB
 3. Telecommunications Bonding Backbone - TBB
 4. Grounding Equalizer - GE

1.07 WORK BY OWNER

- A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.08 SUBMITTALS

- A. Refer to Section 27 0000 - General Communications Requirements which provides general guidelines for product or installation information to be submitted by Contractor.

1.09 QUALITY ASSURANCE

- A. Refer to Section 27 0000 - General Communications Requirements which identifies general quality assurance requirements for the Project.

1.010 GUARANTEE

- A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

PART 2 - PRODUCTS

2.01 TELECOMMUNICATIONS BUSBARS

- A. Material: Copper (aluminum not permitted)
 1. 1/4" thick
- B. Pre-drilled
 1. 3/8" Diameter
 2. Hole spacing per ANSI Joint Standard J-STD-607-A
 3. Hole pattern shall accommodate two-hole lugs
- C. Insulators and stand-off brackets shall electrically isolate busbar from wall or other mounting surface.
- D. Busbars shall be listed by nationally recognized testing laboratory.
- E. Size:
 1. Telecommunications Main Ground Busbar (TMGB) – 20" x 4" (minimum)
 2. Telecommunications Grounding Busbar (TGB) – 12" x 2" (minimum)

2.02 CONDUCTORS

- A. Material: Stranded copper (aluminum not permitted)

- B. Bonding Conductors shall be insulated.
 - 1. Green Jacket or Black Jacket marked with Green Tape or Green adhesive labels per NEC Guidelines
- C. Size:
 - 1. Telecommunications Bonding Conductor (TMGB to Grounding Electrode): **[As indicated on Project Drawings] [3/0 AWG] [4/0 AWG]**
 - 2. Telecommunications Bonding Backbone (TBB; TMGB to TGB): **[As indicated on Project Drawings]**
 - a. **[Up to 66 ft - 2/0 AWG]**
 - b. **Greater-than 66 ft - 3/0 AWG]**
 - 3. Grounding Equalizer (GE): **[As indicated on Project Drawings]**
 - a. **[Up to 66 ft - 2/0 AWG]**
 - b. **Greater-than 66 ft - 3/0 AWG]**

2.03 CONNECTIONS

- A. Mechanical Connectors
 - 1. Connector Body shall:
 - a. Be high-strength, high-conductivity cast copper alloy
 - b. Be 2 bolt type
 - 2. Bolts, nuts, washers and lock-washers: Silicon Bronze
 - a. Shall be supplied as part of connector body
 - b. Split bolt connector types are not allowed
 - 3. Connector shall:
 - a. Meet or exceed UL 467
 - b. Be clearly marked with catalog number, conductor size and manufacturer.
- B. Compression Connectors
 - 1. Connector Body: pure wrought copper.
 - a. Conductivity shall be no less than 99% by IACS standards.
 - 2. Connector shall:
 - a. Meet or exceed performance requirements of IEEE 837, latest revision
 - b. Be factory filled with an oxide-inhibiting compound
 - c. Be clearly marked with manufacturer, catalog number, conductor size and required compression tool settings
 - 3. Connection shall be irreversible.
- C. Exothermic Weld Connections
 - 1. Not Allowed

PART 3 - EXECUTION

3.01 SEQUENCING AND SCHEDULING

- A. Permanently attach communications grounds prior to energizing communications equipment.

3.02 TOPOLOGY

- A. Refer to the project drawings.

3.03 INSTALLATION

- A. Provide required elements and miscellaneous hardware necessary to establish Telecommunication Grounding infrastructure as specified.
- B. Install Products in accordance with manufacturer's instructions.
 - 1. Install Compression Connectors with compression, tool and die system, as recommended by manufacturer of connectors.
- C. Grounding connections shall be tight and shall be made with UL listed grounding devices, fittings, bushings, etc.

- D. On the Telecommunications Bonding Conductor, Telecommunications Bonding Backbone (TBB) and Grounding Equalizer (GE) all connections shall be Compression type.
- E. Locate TGBs and TMGB per drawings.
- F. Telecommunications Bonding Backbone (TBB) shall be continuous and not interrupted by Telecommunications Grounding Busbars (TGB).
 - 1. TGBs shall be bonded to TBB via tap off of TBB.
 - a. Exception is "last" TGB on TBB (e.g. furthest from TMGB).
 - 2. Grounding Equalizer(s) (GE) shall connect to TGBs to be interconnected.
- G. Insulate Busbars from their support.
- H. Connections shall be bare metal to bare metal contact.
 - 1. Clean surfaces of paint, dirt, oil, etc.
- I. Connections shall be exposed and visible for inspection at all times.
 - 1. Do not install insulation over ground connections.
- J. Terminate each grounding conductor on its own terminal lug.
 - 1. Multiple conductors on single lug not permitted.

3.04 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Test resistance of each TGB to ground.
 - 1. Maximum resistance to ground shall be less than 5 Ohms.

3.05 DOCUMENTATION

- A. Accurately record actual locations of grounding electrode(s), busbars and backbone grounding conductors.

END OF SECTION

SECTION 27 0528.29
HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

- A. This section includes product and execution requirements for items unique to communications systems and not included in Division 26 sections.
- B. Refer to Section 27 0000 – General Communications Requirements and 26 0529 - Hangers and Supports for Electrical Systems - Part 1 for requirements for Reference Standards, Submittals, Quality Assurance, Delivery/Storage/Handling, and Guarantee.

1.02 RELATED WORK

- A. Related Division 27 Sections include:
 - 1. Section 27 0000 - General Communications Requirements
 - 2. Section 27 0528.33 - Raceway and Boxes for Communications Systems
 - 3. Section 27 0528.36 - Cable Tray for Communications Systems
 - 4. Section 27 0549 - Seismic Anchorage and Restraints
 - 5. Section 27 1000 - Structured Cabling
 - 6. Section 27 1100 - Communications Equipment Room Fittings
 - 7. Section 27 1300 - Communications Backbone Cabling
 - 8. Section 27 1500 - Communications Horizontal Cabling
- B. Related sections in other Divisions of Work:
 - 1. Section 26 0529 - Hangers and Supports for Electrical Systems
 - 2. Section 26 0548 - Vibration And Seismic Controls For Electrical Systems

1.03 REFERENCES AND STANDARDS

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

- A. Refer to Section 26 0529 - Hangers and Supports for Electrical Systems - Part 3 for:
 - 1. Hanger Rods
 - 2. Beam Clamps
 - 3. Wall Anchors
 - 4. Metal Framing

2.02 J-TYPE CABLE SUPPORT HOOKS

- A. Cable support hooks shall be a wide-base type for use in a non-continuous pathway.
- B. Hook material shall be Galvanized metal or Nylon for smooth cable pull and corrosion resistance.
 - 1. Hook may be coated to reduce cable friction.
 - 2. Hook material shall be rigid. Flexible material not allowed.
- C. Hooks shall:
 - 1. Comply with UL, cUL, NEC and TIA requirements for structured cabling systems.
 - 2. Be designed to limit cable bending per cable manufacturers' recommendations.
 - 3. Be capable of being installed in a single- or multiple-hook ("tree") configuration.
 - 4. Incorporate a latch or other mechanism to retain cable.

PART 3 - EXECUTION

3.01 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

- A. Refer to Section 26 0529 - Hangers and Supports for Electrical Systems - Part 3 for all products identified in Part 1.

3.02 J-TYPE CABLE SUPPORT HOOKS

- A. Where installed free-air above suspended ceiling or below raised floor, support cables using J-hook type cable supports installed in accordance with manufacturer's installation requirements.
- B. Support hooks from structure. Do not support from ceiling grid, conduit or other trades work.
- C. Space J-hook cable supports every 4 ft or in accordance with cable manufacturer's specifications, whichever distance is shorter.
- D. J-hook fill capacities shall be per manufacturer's recommendations and shall consider diameter of cable type(s) being installed.

END OF SECTION

SECTION 27 0528.33
RACEWAY AND BOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

- A. This section includes product and execution requirements for items unique to communications and not included in Division 26 sections.

1.02 DESCRIPTION

- A. Refer to Section 26 0533 - Raceway and Boxes for Electrical Systems - Part 1 for requirements for Standards, Submittals, Quality Assurance, Delivery/Storage/Handling, and Guarantee for:
1. Outlet Boxes
 2. Pull and Junction Boxes
 3. Raceways and Wireways (including sleeves, expansion fittings, penetrations and seals)
 4. Indoor Service Poles
 5. Poke-through Fittings
 6. Floor Boxes
 7. Cable Supports

1.03 RELATED WORK

- A. Related Division 27 Sections include:
1. Section 27 0000 - General Communications Requirements
 2. Section 27 0526 - Grounding and Bonding for Communications Systems
 3. Section 27 0528.29 - Hangers and Supports for Communications Systems
 4. Section 27 0528.36 - Cable Tray for Communications Systems
 5. Section 27 0528.39 - Surface Raceways for Communications Systems
 6. Section 27 0553 - Communications Systems Identification
 7. Section 27 1000 - Structured Cabling
 8. Section 27 1100 - Communications Equipment Room Fittings
 9. Section 27 1300 - Communications Backbone Cabling
 10. Section 27 1500 - Communications Horizontal Cabling
 11. Section 27 5150 - Master Antenna Television Systems
 12. Section 27 5223 - Nurse Call System
- B. Related sections in other Divisions of Work:
1. Section 26 0533 - Raceway and Boxes for Electrical Systems

1.04 REFERENCES AND STANDARDS

- A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

- A. Refer to Section 26 0533 - Raceway and Boxes for Electrical Systems - Part 2 for Outlet Boxes for Communications, Pull and Junctions Boxes for Communications, Raceways for Communications, and other products identified in Part 1.
- B. **[Refer to Section 27 5223 - Nurse Call and Nurse Call Schedule for box size(s) and configuration for Nurse Call system rough-in.]**

2.02 COMMUNICATIONS RACEWAYS

- A. OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY (INNERDUCT)
1. UL 2024; flexible type, approved for **[plenum] [riser] [general purpose] [flame-retardant]** installation
 2. Outdoor Innerduct: Smooth outside and ribbed inside

3. Indoor Innerduct: Corrugated
4. Color:
 - a. General Purpose: **[Orange]** []
 - b. Flame-retardant: **[Orange]** []
 - c. Riser: **[Orange]** []
 - d. Plenum: **[Orange]** **[White]** []
5. Manufacturers: Carlon; Pyramid; []; **[Approved equal]**

2.03 MULTI-CELL FLEXIBLE RACEWAY

- A. Manufacturers: MaxCell™.
- B. Multi-cell flexible raceway shall be a flexible, multi-celled, textile innerduct system designed for communications.
- C. Multi-cell flexible raceway shall meet the following physical requirements:
 1. UL 2024; flexible type, approved for **[plenum (OFCR FT-6)] [riser (OFCR FT-4)]** installation
 2. Tensile strength: 2500 lbs or better
 3. Melting Point: 480°F or better
 4. Resistant to ground chemicals and petroleum products
 5. Unaffected by mud, silt or debris after placement of cable.
- D. Shall be pre-lubricated for lower friction during flexible raceway and cable installation.
- E. Multi-cell flexible raceway color shall be WHITE.
 1. Multi-cell flexible raceway shall include a color coded stripe allowing for identification of each bundle.
- F. Each cell shall include a color-coded pull tape.
- G. Product shall be available in a variety of sizes and cell counts. Refer to project Drawings.

PART 3 - EXECUTION

3.01 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

- A. Refer to Section 26 0533 - Raceway and Boxes for Electrical Systems - Part 3 for Outlet Boxes for Communications, Pull and Junctions Boxes for Communications, Raceways for Communications, and other products identified in Part 1.

1.1 COMMUNICATIONS RACEWAYS

- B. Optical Fiber Communications Cable Raceway (Innerduct):
 1. Minimum innerduct size: 1", unless otherwise noted on drawings.
 2. Extend innerduct to termination and/or storage enclosure.
 3. Provide couplings designed for innerduct size and type where innerduct enters a termination and/or storage enclosure.
 4. Splice innerduct segments using couplings designed for that purpose, where not installed in a continuous length.
 5. Provide 200 lb nylon pull cord in empty innerduct. Leave at least 12" of slack at each end of pull wire. Cap innerduct at both ends.
 6. Label innerduct with tags indicating cable type and cables contained therein.
 - a. Label in each maintenance hole, pull box and communications equipment room, where exiting a conduit and at **[10 ft] [20 ft] [35 ft]** intervals in cable tray or where otherwise exposed.

3.02 MULTI-CELL FLEXIBLE RACEWAY

- A. Segment conduits to increase capacity.
 1. Provide quantity and size per project Drawings.
- B. Install per manufacturers recommendations.

END OF SECTION

SECTION 27 0528.36
CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Related Division 27 Sections include:
 - 1. Section 27 0000 - General Communications Requirements
 - 2. Section 27 0526 - Grounding and Bonding for Communications Systems
 - 3. Section 27 0528.29 - Hangers and Supports for Communications Systems.
 - 4. Section 27 0528.33 - Raceway and Boxes for Communications Systems
 - 5. Section 27 0549 - Seismic Anchorage and Restraints
 - 6. Section 27 1000 - Structured Cabling
 - 7. Section 27 1100 - Communications Equipment Room Fittings
 - 8. Section 27 1300 - Communications Backbone Cabling
 - 9. Section 27 1500 - Communications Horizontal Cabling
- B. Related sections in other Divisions of Work:
 - 1. Section 26 0526 - Grounding and Bonding for Electrical Systems
 - 2. Section 26 0529 - Hangers and Supports for Electrical Systems
 - 3. Section 26 0533 - Raceway and Boxes for Electrical Systems
 - 4. Section 26 0536 - Cable Trays for Electrical Systems
 - 5. Section 26 0548 - Vibration and Seismic Controls for Electrical Systems
 - 6. Section 26 0593 - Electrical System Firestopping

1.02 REFERENCE

- A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 DESCRIPTION

- A. Provide complete cable tray system including straight tray sections, fittings, splice plates, and cable tray supports to support cable systems in locations as indicated on drawings.
- B. Cable tray system is intended to carry communications cable only. Fire alarm system and overhead page cables are not allowed.

1.04 REFERENCE STANDARDS

- A. ASTM A 123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and forged Steel Shapes, Plates, Bars, and Strip.
- B. ASTM A 446 - Specification for Zinc-Coated (Galvanized) by Hot-Dip Process, Structural (Physical) Quality.
- C. ASTM A 525 - Specification for Steel Sheet, Zinc-Coated Galvanized by Hot Dip Process.
- D. ASTM A 607 - Specification for Steel Sheet and Strip, Hot-rolled and Cold-Rolled, High Strength, Low Alloy Columbium or Vanadium.
- E. ASTM B 633 - Specification for Electro-deposited Coatings of Zinc on Iron and Steel.
- F. NEMA VE 1 - Metal Cable Tray Systems.
- G. NEMA VE 2 - Cable Tray Installation Guidelines
- H. BICSI - Telecommunications Distribution Methods Manual (TDMM)

1.05 SUBMITTALS

- A. Submit shop drawings for equipment provided under this Section.
- B. Submit as-built drawings showing floor plan locations, elevation changes, and conduit drops.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Acceptable Manufacturers

1. Cooper B-Line (FLEXTRAY™)
2. Chalfant Cable Trays
3. Mono-Systems (Mono-Mesh™)
4. MP Husky
5. Legrand (CABLOFIL®)
6. WBT

2.02 MATERIALS AND FABRICATION

A. Materials of Construction:

1. Materials shall be adequately protected against corrosion or made of corrosion resistant material.

B. Wire Mesh Trays

1. Tray shall be continuous, rigid, welded steel wire mesh cable management system.
2. Maximum mesh dimension shall be 2 x 4 inches (50 x 100 mm).
 - a. Wire diameter shall be at least 5 mm.
3. Material shall be carbon steel wire, ASTM A510, Grade 1008. Wire welded, bent, and surface treated after manufacture
4. Finish shall be Electro-Plated Zinc Galvanizing per ASTM B 633, Type III, SC 1 or Electro-plated yellow zinc dichromate in accordance with ASTM B 633, Type III, SC 2.
5. Dimensions:
 - a. Inside width: **[As indicated on Project Drawings] [XXX]**
 - b. Loading depth (NEMA VE 1): **[4" minimum] [2" minimum] [XXX]**
6. Tray system shall not present sharp edges, burrs or projections injurious to wiring.
7. Hardware, including splice connectors and support components, shall be furnished by tray manufacturer.
8. Tray shall be UL classified for use as an equipment grounding conductor.
9. Tray shall be designed to support volume capacity of cables and provide safe mechanical support for spans up to 8 feet (2.4 meters) on center. Tested load deflection data is available either in accordance with NEMA VE 1 or IEC 61537 standards
10. Splice plates shall be bolted type made specifically for tray type provided.
 - a. Splice plate construction shall be designed to permit splice location at any point within support span without diminishing cable tray rated loading capacity.

2.03 SUPPORT SYSTEM

- A. Supports shall comply with product requirements defined in specification section 26 0529 - Hangers and Supports for Electrical Systems.
- B. Flexible cordage/wire shall not be used.

2.04 ACCESSORIES

- A. Special accessories shall be furnished as required to protect, support, and install cable tray system.
 1. Accessories include section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts and barriers.

PART 3 - EXECUTION

3.01 GENERAL

- A. Provide complete cable tray system, including straight tray sections, fittings, splice plates, and cable tray supports to support cable systems in locations, as indicated on drawings.
- B. Comply with manufacturer's recommended installation practices in addition to applicable standards and codes.
- C. Completed installation shall present smooth surfaces and rounded edges with no burrs, projections or sharp edges that may prove injurious to installed wiring.

3.02 WIRE MESH

- A. Cut wires in accordance with manufacturer's instructions.
- B. Cut wires with side action bolt cutters to ensure integrity of galvanic protective layer.
- C. Cut each wire with one clean cut to eliminate grinding or touch-up.

3.03 INSTALLATION

- A. Install metallic cable tray in accordance with NEMA VE 1 and VE 2.
- B. Provide manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, connectors, and grounding straps as required.
- C. Provide blind end plates for trays that dead end.
- D. Provide full-width dropouts (4" minimum bend radius) where cables exit from tray bottom.
- E. Join cable tray system sections at ends using manufacturer prefabricated splice plates.
 1. No more than one cable tray splice shall be placed between support spans.
- F. Tray system shall be accessible, with sufficient space provided about cable trays to permit side and top access for installation and maintenance of cables.
 1. Coordinate installation of cable tray to maintain clearance between cable tray and other trades work.
 2. Clearance shall be minimum 18" on at least one side, 12" on top and 6" below cable tray.
 - a. **[Perpendicular crossings not meeting clearance above tray are acceptable, in lengths not to exceed 60".]**
 - b. **[Where clearances defined above cannot be met, contractor shall provide 4" conduits in quantity equivalent to specified cable tray]**
 3. Tray shall not restrict removal of ceiling panels or lighting assemblies.
 4. Notify Engineer for clarification and direction before proceeding with installation if access conditions cannot be met.
- G. Do not install cable tray below re-heat coils, VAV boxes, traps, or other building components that require access from below.
- H. Refer to specification section 27 1000 - Structured Cabling for separation requirements from potential EMI sources.
- I. Provide prefabricated expansion splice plates at intervals as defined in NEMA VE 2 and where cable tray systems cross building expansion joints.
- J. Provide minimum of 1 expansion splice plate in straight runs which exceed 12 ft for tray installations in exterior areas.
- K. Field fabricate fittings in accordance with manufacturer's instructions.
 1. Minimum inside radius of fittings shall approximate **[12-inch (300-mm)] [18-inch (450-mm)]** radius available using ladder-type cable tray.
- L. Where cable tray would penetrate fire rated wall, stop tray at wall and fasten tray end to wall.
 1. Provide quantity of **[4" sleeves][re-enterable, self-sealing, fire rated cable assemblies]** with cross sectional area equivalent to cable tray.
 - a. Each **[sleeve][cable assembly]** shall maintain maximum of 40% cable fill ratio.
 - b. **[Provide plastic bushings on both ends of each sleeve.]**
 2. **[Sleeves][Cable assemblies]** shall extend beyond both sides of fire rated wall as required to meet UL fire rated assembly requirements. Final assembly shall carry UL listing to maintain fire and smoke rating of wall penetrated.
 3. Provide UL listed grounding connectors and conductors to extend cable tray grounding path through wall penetration.
- M. Where cable tray distribution system encounters inaccessible ceiling area, provide sufficient 4" EMT sleeves/conduit through area to maintain same available cross sectional area as cable tray.
 1. Each sleeve/conduit shall maintain maximum of 40% cable fill ratio.

- N. Place barriers to obtain size of each raceway as noted on drawings.
- O. Secure barriers into cable tray system using prefabricated barrier strip clips. Join barriers at ends using manufacturer prefabricated barrier strip splices.
- P. Provide bolts and nuts in all holes of cable tray fittings per manufacturer's installation instructions.
- Q. Cable tray systems shall be electrically continuous.
- R. Nicks and scratches and ends of cut sections with galvanized coatings shall be coated, with approved coating that matches cable tray finish, after tray installation.

3.04 SUPPORT

- A. Support cable tray system utilizing trapeze hangers from building or other structural steel members, angle brackets from vertical structural steel members, upright angle brackets on pipe racks, or directly upon horizontal structural steel members of the building or pipe racks.
 - 1. Center run hangers are not allowed.
 - 2. Cable tray may be wall mounted only in cases where trapeze mounting from above is not possible due to obstructions. Contractor shall review such situations with Engineer for approval prior to installation.
- B. Supports shall be constructed from formed shape channel members 1.625" x 1.625", pre-galvanized 14 Ga. steel complete with nuts, bolts, washers, lock washers and tray clamps as required for complete and finished installation.
 - 1. Where formed mounting assemblies are part of manufacturer's integrated cable tray system, these may be used in compliance with manufacturers recommended practices.
- C. Threaded rod used for tray support shall be 3/8" minimum diameter.
- D. Size, anchor, and space supports to sustain weight of cable tray system, cable, and tubes that are to be installed into cable tray, and 200 lbs excess on any individual section, with safety factor of **[1.5][XXX]** minimum when supported as simple span and tested per NEMA requirements. Load and safety factors are applicable to all tray components.
- E. Calculate supports based on **[60 lbs/ft] [XXX]** load of cables and tubes. Support spans shall not exceed manufacturer's recommendations.
- F. Total vertical tray deflection shall not exceed 1-1/2" between supports when tray is loaded to capacity.
- G. Include dynamic loads in calculations for outside area installations.
- H. Maximum allowable deviation of tray, from level horizontal plane measured across width of tray, is one half of one inch (1/2") with tray loaded to capacity.
 - 1. Approval of installation method does not relieve contractor from meeting above deviation requirement. If additional support is needed, as determined by project engineer, contractor shall provide additional support at no additional cost

3.05 GROUNDING

- A. Cable tray systems shall be electrically continuous.
 - 1. Bonding Jumpers shall be used between discontinuous tray sections as called for in manufacturer's installation guidelines to maintain grounding continuity of cable tray system.
 - 2. Grounding connections to tray shall be made using a UL listed mechanical connection.
- B. Connect each cable tray system subassembly to building ground system using grounding clamps and grounding conductors. Provide 3.0 ohm maximum resistance to building ground connection.
- C. Cable tray shall not be connected to instrumentation grounding system.
- D. Bond conduits to cable tray as defined by NEC references in NEMA VE-1 and VE-2.

END OF SECTION

SECTION 27 0553
COMMUNICATIONS SYSTEMS IDENTIFICATION

PART 1 - GENERAL

1.01 SCOPE

- A. This section details product and execution requirements for labeling of communications cabling, termination components, pathways and spaces for Communications Systems.

1.02 DESCRIPTION

- A. All components shall be clearly labeled to identify them as unique throughout the project.
- B. Labeling requirements include identification of Rooms, Equipment Racks, Telecommunications Outlets, Horizontal and Backbone Cabling, Termination Hardware (Patch Panels, Blocks) and Grounding.

1.03 RELATED WORK

- A. Related Division 27 Sections include:
 - 1. Section 27 0000 - General Communications Requirements
 - 2. Section 27 0526 - Grounding and Bonding for Communications Systems
 - 3. Section 27 1000 - Structured Cabling
 - 4. Section 27 1100 - Communications Equipment Room Fittings
 - 5. Section 27 1300 - Communications Backbone Cabling
 - 6. Section 27 1500 - Communications Horizontal Cabling
 - 7. Section 27 5150 - Master Antenna Television Systems
 - 8. Section 27 5223 - Nurse Call System
- B. Related sections in other Divisions of Work:
 - 1. Refer to individual technical sections identified above (if applicable).

1.04 REFERENCES AND STANDARDS

- A. Refer to Section 27 0000 - General Communications Requirements which identifies pertinent References and Standards.
- B. Other applicable references and standards include:
 - 1. TIA-606-C - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

1.05 DEFINITIONS

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Definitions used in this and related sections.

1.06 ABBREVIATIONS AND ACRONYMS

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Abbreviations and Acronyms used in this and related sections.

1.07 WORK BY OWNER

- A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.08 SUBMITTALS

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide general guidelines for product and/or installation information to be submitted by contractor.
- B. Prior to installation, provide samples of label types planned for the project.
 - 1. Samples shall include examples of lettering to be used and shall follow standards detailed below.

1.09 QUALITY ASSURANCE

- A. Refer to Section 27 0000 - General Communications Requirements which identifies general quality assurance requirements for the project.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Labels and markings shall be physically and chemically resistant to damage that would make label unreadable.
- B. Cable labels shall be self-laminating, White/Transparent Vinyl (or other substrates facilitating easy application and flex as cables are bent) and incorporate an integrated clear lamination which covers printed part of label when label is wrapped around cable.
 - 1. If cable jacket is white, provide cable label with printing area that is a color other than white to easily distinguish label from cable jacket.
 - 2. Labels shall be of adequate size to accommodate circumference of cable(s) being marked and properly self-laminate over full extent of printed area of label.
 - 3. Labels on larger cables (e.g. Copper Backbone) may be wrapped with clear non-removable tape.
- C. Labels shall use aggressive adhesives that stay attached even to the most difficult to adhere to jacketing. Tags shall be non-removable.
 - 1. Exceptions:
 - a. Telecommunications Outlet labels that are placed in recessed label holders.
 - b. Telecommunications Ground tags secured with cable ties.
 - c. Innerduct Tags secured with cable ties.
- D. Labels for 110-type Termination Blocks shall be Color-coded to indicate the cable type (inter-building, intra-building backbone, horizontal, etc.). Refer to Part 3.

PART 3 - EXECUTION

3.01 GENERAL

- A. Labeling shall be by mechanical means.
 - 1. Hand lettered designations are not allowed.
- B. Tags shall be non-removable.
 - 1. Exceptions:
 - a. Telecommunications Outlet labels that are placed in recessed label holders.
 - b. Telecommunications Ground tags secured with cable ties.
 - c. Innerduct Tags secured with cable ties.
- C. Characters shall be Black Ink and printed on background of contrasting color.
- D. Labels shall match hardware layout and design.
- E. Labels shall be as large as practicable while fitting properly.
- F. No lettering shall be smaller than 10-point.
- G. Label cables with tag which is wrapped around cable sheath.
 - 1. Clean cable sheath thoroughly before applying label.
 - 2. Labels shall not be obscured by termination hardware.
- H. Label equipment mounted above ceilings (e.g. telecommunications outlets, consolidation points, ceiling-mounted enclosures) with label affixed to exposed side of ceiling components.
 - 1. Labels shall be viewable by individuals standing on finished floor level.
 - 2. Affix labels with label edges square with edges of ceiling component to which they are affixed.
 - 3. Where equipment is mounted within enclosure flush-mounted into ceiling structure with enclosure panel viewable from finished floor level, affix label:
 - a. along exposed enclosure panel edge
 - b. on smooth enclosure panel surface in location which does not interfere with enclosure panel operation.

4. Where equipment is mounted above accessible ceiling structure (e.g. acoustic ceiling tile with exposed support grid):
 - a. affix label on smooth support grid element located adjacent to ceiling tile providing most direct access to equipment mounted above.
 - b. append and prepend label with arrow characters indicating which adjacent ceiling tile provides equipment access
 - 1) ARROW CHARACTER FONT SIZE SHALL MATCH LABEL FONT SIZE
 - 2) ARROW CHARACTERS SHALL BE SEPARATED FROM LABEL TEXT BY 2 BLANK SPACES
5. Where equipment is mounted above inaccessible ceiling structure, affix label:
 - a. along frame edge of access panel providing access through inaccessible ceiling.
 - b. on smooth access panel frame surface in location which does not interfere with access panel operation.

3.02 ROOM IDENTIFICATION

- A. Label Communications Backboard or Equipment Rack closest to entry door with unique identifying code.
- B. Characters shall be **25 mm(1")** minimum.
- C. Room ID shall be [XXX]

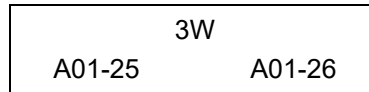
3.03 EQUIPMENT RACK IDENTIFICATION

- A. Label each Equipment Rack with **[a unique alpha character starting at "A"] [unique identifying code as follows:**
 1. **TR-##, where:**
 - a. **"TR" is identifier for room where rack is located**
 - b. **"##" is sequential number for rack starting at "01".]**
- B. Position Labels at top of rack.
- C. Characters shall be 1-inch minimum.

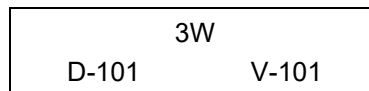
3.04 TELECOMMUNICATIONS OUTLET

- A. Label each Telecommunications Outlet (TO) connector with unique identifying code.
- B. Telecommunications Outlet connector numbering shall result in logical numbering sequence in work area.
 1. Labeling plans that results in random TO numbering in work area are not acceptable.
- C. Place Faceplate labels on outside of cover.
- D. Position Labels in recessed label holders on faceplate and covered with clear plastic covers.
 1. Where Communications Outlet Faceplates not incorporating recessed holders are allowed, faceplate labels shall be protected with clear laminate.
- E. Telecommunications Outlet labeling code shall be as follows:
 1. TR-RPP-##, where:
 - a. "TR" is identifier for room where cable terminates in horizontal cross-connect.
 - b. "R" is identifier for Equipment Rack where cable terminates
 - 1) ALPHA CHARACTER STARTING AT "A".
 - c. "PP" is Patch Panel on which cable is terminated at HC.
 - 1) NUMBER STARTING AT "01".
 - 2) PANEL NUMBERING SHALL BE FROM TOP (OF RACK) TO BOTTOM.
 - d. "##" is sequential POSITION of Jack on Panel
 - 1) 1 - 48 IS TYPICAL
 - 2) POSITION SEQUENCE SHALL BE LEFT-RIGHT AND TOP-BOTTOM.
 2. Example: "3W-A03-25" represents 25th Jack Position in 3rd Panel on Equipment Rack "A" in Telecom Room "3W".

- a. Faceplate labels can use common TR identifiers on each label strip. For example, two data jacks served from TR 3W sharing common label strip may be represented by:



1. TR-Y-ZZZ, where:
 - b. TR = Identifier for room where cable terminates in horizontal cross-connect.
 - c. Y = Cable type (V = Voice, D = Data, F = Fiber Optic, T = CATV coax)
 - d. ZZZ = Jack # (001,002, etc.)
3. Faceplate labels can use common room number designations on each label strip. For example, one voice and one data jack served from TR 3W sharing common label strip may be represented by:



3.05 HORIZONTAL CABLING

- A. Label each horizontal cable at Telecommunications Outlet and at horizontal cross-connect with unique identifying code.
- B. Cable shall be labeled at both ends within 4" of cable choke (end of jacket).
- C. Horizontal labeling code shall be **[same as identified for Telecommunications Outlet above]** **[as follows]:**
 1. **[ENTER Horizontal Cable ID guidelines]**

3.06 MODULAR PATCH PANEL

- A. Label each patch panel and port at horizontal cross-connect with unique identifying code.
- B. Patch panel labeling code shall be **[same as identified for Telecommunications Outlet above]** **[as follows]:**
 1. **Label Panel I.D.**
 - a. **Panel numbering shall be from Top to Bottom**
 2. **Label Individual Port I.D.**
 - a. **Port I.D. shall be from Left to Right, Top to Bottom.**
 - b. **Manufacturers port labeling is acceptable.]**
- C. Room number is not required on modular patch panels.
- D. Equipment Rack number is not required on modular patch panels.

3.07 BACKBONE COPPER CABLE

- A. Label each backbone cable at both ends at termination point with unique identifying code.
- B. Label cable sheath:
 1. At point where sheath ends
 2. At point on cable where viewing of label is not obscured by termination blocks or other visual barrier.
- C. Label shall be on plastic tag tie-wrapped to cable sheath, or placed on adhesive labels adhered to cable sheath.
 1. If adhesive labels are used, place clear plastic tape over label to protect it and maintain adhesion to sheath.
- D. Label Intra-building cables with:
 1. From and to locations,
 2. Pair numbers
 - a. Where multiple cables are installed between same end-points, labeling shall indicate sequential pair numbering.

- 1) FOR EXAMPLE 400-PAIR PROVIDED AS TWO 200-PAIR CABLES WOULD BE LABELED "001-200" AND "201-400".
- 3. Date installed.
 - a. Example 200-pair cable from ER106 to TR3164 installed October 2009:

ER106-TR3164
001-200
10/2009

- E. Label Inter-building (between buildings) cables with:
 - 1. From and to locations,
 - 2. Pair numbers
 - a. Where multiple cable is installed between same end-points, labeling shall indicate sequential pair numbering.
 - 1) FOR EXAMPLE 400-PAIR PROVIDED AS TWO 200-PAIR CABLES WOULD BE LABELED "001-200" AND "201-400".
 - 3. Date installed.
 - a. Example 600-pair Cable from Building 108 ER to Building 110 ER installed October 2009:

ER180-ER110
001-600
10/2009

3.08 TERMINATION BLOCKS

- A. Provide color-coded designation strips with Termination Blocks.
- B. Label termination positions on designation strips with position identifier.
- C. Horizontal Cabling Blocks shall incorporate BLUE Designation Strips and shall identify:
 - 1. Telecommunications Outlet / Jack I.D.s
- D. Intra-Building (within building) Backbone Cabling Blocks shall incorporate WHITE Designation Strips.
 - 1. Label Designation Strips with:
 - a. Cable Origin & Destination
 - 1) REPEAT ON EVERY DESIGNATION STRIP.
 - b. Pair Count.
 - 1) LABEL 1ST AND 25TH POSITIONS ON EACH ROW (E.G. 001 & 025, 026 & 050, ETC.).
 - 2. Example ER106 to TR3164:

001	ER106-TR3164	025
026	ER106-TR3164	050

- E. Inter-Building (between buildings) Backbone Cabling Blocks shall incorporate BROWN Designation Strips.
 - 1. Label Designation Strips with:
 - a. Cable Origin & Destination
 - 1) REPEAT ON EVERY DESIGNATION STRIP.
 - b. Pair Count
 - 1) LABEL 1ST AND 25TH POSITIONS ON EACH ROW (E.G. 001 AND 025, 026 AND 050, ETC.).
 - 2. Example cable linking Building 123 ER and Bldg. 456ER:

001	123ER-456ER	025
026	123ER-456ER	050

- F. Voice "Multiplier" Blocks shall incorporate YELLOW Designation Strips.
1. Label each designation strip with "Multiplier"
 2. LABEL 25-PAIR ROWS IN 100-PAIR MULTIPLIER BLOCK AS "A" (1ST 25-PAIR). "B" (2ND 25-PAIR), "C" AND "D".
 3. LABEL PAIR COUNT
 - A. LABEL 1ST BLOCK 001 - 025; LABEL 2ND BLOCK 025 - 050, ETC.
 - b. LAbel 1st and 25th Positions on each row (e.g. 001 and 025, 026 and 050, etc.).
 4. Example:

A001	MULTIPLIER	A025
B001	MULTIPLIER	B025

C001	MULTIPLIER	C025
D001	MULTIPLIER	D025

- G. Feed Blocks (from Access/Service Provider) shall incorporate GREEN Designation Strips.
1. Label Designation Strips with:
 - a. Designation as "FEED CABLE"
 - b. Pair Count.
 2. Example (Verizon as Service Provider):

1201	FEED (VERIZON)	1225
1226	FEED (VERIZON)	1250

- H. Telephone system Equipment Blocks shall incorporate PURPLE Designation Strips.
1. Label Designation Strips with:
 - a. Designation (e.g. System or Equipment Type)
 - b. Pair Count.
 2. Example (PBX):

001	PBX	025
026	PBX	050

3.09 BACKBONE FIBER OPTIC CABLING

- A. Label each backbone cable at both ends at termination point with unique identifying code.
- B. Label shall be placed on adhesive labels adhered to cable sheath.
- C. Label Intra-building cables with:
 1. From and to locations,
 2. Fiber type (core/cladding diameter)
 3. Fiber count
 - a. Where multiple cable is installed between same end-points, labeling shall indicate sequential fiber numbering.
 - 1) FOR EXAMPLE 144-FIBERS PROVIDED AS TWO 72-FIBER CABLES WOULD BE LABELED "001-072" AND "073-144".
 4. Date installed.
 5. Example 72-fiber cable from ER106 to TR3164 installed October 2009:

ER106-TR3164
50/125 001-072
10/2009

- D. Label Inter-building cables with:
1. From and to locations,
 2. Fiber type (core/cladding diameter)
 3. Fiber count
 - a. Where multiple cable is installed between same end-points, labeling shall indicate sequential fiber numbering.
 - 1) FOR EXAMPLE 144-FIBERS PROVIDED AS TWO 72-FIBER CABLES WOULD BE LABELED "001-072" AND "073-144".
 4. Date installed.
 5. Example 72-fiber cable from Building 108 ER to Building 110 ER installed October 2009:

ER108-ER110
50/125 001-072
10/2009

3.010 FIBER OPTIC PATCH PANELS

- A. Label each fiber coupling in patch panel or workstation outlet with unique identifying code.
- B. Patch panel labels shall be visible from front of panel without opening panel cover.
- C. Place labels in manufacturer designated labeling areas.
- D. Label Fiber Optic Patch Panels with unique labeling code to identify:
 1. **[Cable Destination] [Cable Number]**
 2. Fiber type (core/cladding diameter)
 3. Fiber (or coupler) number of each panel position.
 - a. Port I.D. shall be from Top to Bottom, Left to Right,
 - b. Manufacturers port labeling is acceptable.
- E. Label Fiber Optic Patch Panels with unique labeling code to identify:
 1. Patch panel number in rack
 2. Fiber (or coupler) number of each panel position.
 - a. Port I.D. shall be from Top to Bottom, Left to Right,
 - b. Manufacturers port labeling is acceptable.
- F. Room number is not required on fiber optic patch panels.
- G. Equipment Rack number is not required on fiber optic patch panels.

3.011 INNERDUCT

- A. Innerduct containing fiber optic cable installed under this project shall be labeled where exposed.
 1. Includes areas where innerduct is installed in trays and in equipment rooms.
- B. Label innerduct with durable Yellow Polyethylene tag that reads "CAUTION FIBER OPTIC CABLE"
 1. Tag shall provide blank spaces for adding fiber count and cable destination information.
- C. Label Tag to include:
 1. Identifier(s) of cable(s) contained therein.
 - a. Use Backbone Cable labeling formats as described above.
- D. Hand lettering is acceptable on tag
 1. Use an indelible type ink.
- E. Tag shall be secured to Innerduct using self-locking ties.

3.012 TELECOMMUNICATIONS GROUNDS

- A. Label Grounds as close as practicable to point of termination.
- B. Labels shall be non-metallic and include the following:

WARNING
IF THIS CONNECTOR OR
CABLE IS LOOSE OR MUST BE
REMOVED, PLEASE CALL THE
BUILDING
TELECOMMUNICATIONS
MANAGER.

END OF SECTION

**SECTION 27 0800
AUDIOVISUAL SYSTEM TESTING**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. General provisions
 - 2. Execution, standards, and commissioning requirements
- B. Related requirements
 - 1. The work under this section is subject to requirements of the Contract Documents include the General Conditions, Modifications to the General Conditions, Supplemental Conditions, and sections under Division 1 General Requirements.
 - 2. Section 26 00 00: General Electrical Provisions
 - 3. Section 27 08 00A: Audiovisual Systems Testing Checklist
 - 4. Section 27 41 00: Audiovisual Systems

1.02 REFERENCES

- A. Definitions
 - 1. When the following abbreviations and definitions are used in relation to the work for this Section they shall have the following meanings:
 - a. AEI NW: Affiliated Engineers NW, Inc.
 - b. AHJ: Authority Having Jurisdiction
 - c. AVSC: Audiovisual Systems Contractor
 - d. AV Consultant, Consultant, Engineer: AEI NW
 - e. Code: All applicable codes currently enforced at project location
 - f. Connection: All materials and labor required for equipment to be fully operational
 - g. Fully Operational: Tested, approved, and operating to the satisfaction of the AHJ, contract documents, and the Consultant
 - h. Mfr.: Manufacturer
 - i. NEC: National Electrical Code, National Fire Protection Association, Publication #70
 - j. Noted: Shown or specified in the contract documents
 - k. Provide: Furnish and install
 - l. Required: As required by code, AHJ, contract documents, or manufacturer for the particular installation to be fully operational
- B. Reference Standards
 - 1. Perform all work and provide materials and equipment in accordance with the latest referenced codes and standards of the following organizations:
 - a. American National Standards Institute (ANSI)
 - b. Insulated Cable Engineers Association (ICEA)
 - c. National Electrical Manufacturer's Association (NEMA)
 - d. NFPA 70: National Electrical Code as adopted and amended by the Local Jurisdiction
 - e. Underwriter's Laboratories (UL)
 - 2. Inspections and tests shall use the following references:
 - a. Project design specifications
 - b. Project design drawings
 - c. Manufacturer's installation, operation, and instruction manual for each component
 - d. Contractor's shop drawings
 - e. Audiovisual control system program
 - f. ANSI/INFOCOMM 1M-2009, Audio Coverage Uniformity in Enclosed Listener Areas
 - g. "Dashboard for Controls Design Guide", April 2005, InfoComm International.

1.03 SCOPE OF SERVICES

- A. It is the purpose of this specification to assure that all audiovisual systems and equipment, both contractor and owner supplied, are operational and within industry and manufacturer tolerances and are installed and operating in accordance with design specifications.
- B. Successful completion of tests and inspections shall determine suitability for first beneficial use by the Owner.
- C. Work Includes:
 - 1. Provide all test equipment necessary for system checkout and acceptance tests.
 - 2. Perform initial system testing and adjustment as herein prescribed.
 - 3. Prepare and submit Audiovisual System Testing Report.
 - 4. Participate in and assist with operational system commissioning as herein prescribed.
- D. Systems to be inspected and tested:
 - 1. Sound systems, including:
 - a. System inputs and outputs
 - b. Wired and wireless microphone systems
 - c. Audio program sources
 - d. Preamplifiers, mixers, analog signal processors, and digital signal processors
 - e. Audio signal distribution network
 - f. Distribution amplifiers and power amplifiers
 - g. Loudspeakers
 - h. Assistive listening systems
 - i. Recording equipment
 - 2. Video presentation systems, including:
 - a. Video program sources
 - b. Video switchers and routers
 - c. Video signal processing equipment
 - d. Video distribution equipment
 - e. Video displays and projection systems
 - 3. Digital signage systems
 - a. Content management software
 - b. Audiovisual signal acquisition interfaces
 - c. Digital signage servers
 - d. Digital signage distribution
 - e. Video displays and projection systems
 - 4. Audiovisual control systems
 - a. Control system network
 - b. Control system processors
 - c. Control system interface panels
 - d. Control system interfaces

1.04 DIVISION OF RESPONSIBILITIES

- A. The AVSC shall:
 - 1. Coordinate testing schedule with Construction Manager/Owner/Engineer.
 - 2. Notify Owner and Engineer one week before testing.
 - 3. Perform initial system testing and adjustments.
 - 4. Prepare test results with comparison to specified performance and technical requirements, industry standards, and manufacturer's values and tolerances.

5. Assure system equipment is installed in accordance with contract documents, is operational, and within industry and manufacturer's tolerances.
 6. Participate in and assist with systems acceptance testing.
 7. Assure suitability for operation.
- B. The Engineer shall:
1. Participate in and assist with systems acceptance testing.
 2. Recommend acceptance or rejection of the installed systems prior to final completion.
- C. The Construction Manager/Owner shall:
1. Ensure facilities are ready for the work described in this section.
 2. Participate in and assist with systems acceptance testing.

1.05 SUBMITTALS

- A. Preliminary Systems Testing and Adjustment Report
1. Provide 3 copies of complete testing report using printed forms and one copy in Acrobat PDF format. Test report shall include the following:
 - a. Signed statement on Contractor's letterhead that preliminary systems testing and adjustment has been completed and the system is ready for acceptance testing by the Engineer.
 - b. Completed AV Systems Commissioning Checklist for each system or room.
 - c. Recorded measurements of all systems.
 - d. List of equipment used to perform tests. Identify the following:
 - 1) Type
 - 2) Manufacturer
 - 3) Model number
 - 4) Serial number
 - 5) Date of last calibration
 - 6) Documentation of calibration leading to NIST standards
 - e. Name(s) of personnel performing tests
 - f. Signature of project manager responsible for performance and oversight of system testing and adjustments.
- B. Provide completed reports to Engineer no later than 10 days after completion of checklists, testing, and adjustments unless otherwise directed.

1.06 CLOSEOUT SUBMITTALS

- A. Final Systems Acceptance Testing and Adjustment Report
1. Provide 3 copies of complete testing report using printed forms and one copy in Acrobat PDF format. Test report shall include the following:
 - a. Preliminary Systems Testing and Adjustment Report.
 - b. Final AV Systems Commissioning Checklist, as annotated by the Engineer.
 - c. Final recorded measurements of all systems, including any changes that result from the Systems Acceptance Testing performed by the Engineer.
- B. Provide completed reports to Engineer no later than 10 days after completion of checklists, testing, and adjustments unless otherwise directed.

1.07 QUALITY ASSURANCE

- A. Qualifications
1. Work in this section shall be performed by an AVSC who:
 - a. Complies with the requirements of Division 1, and
 - 1) Is licensed to perform work of this type in the project jurisdiction, and
 - 2) Has at least five (5) years of verifiable direct experience with the devices, equipment and systems of the type and scope specified herein, and

- 3) Has a minimum of one full-time staff member who has attended technical system engineering courses taught by Syn-Aud-Con in the past ten (1) years, and
 - 4) Has an active membership in the National Systems Contractors Association (NSCA), or
 - 5) Has an active membership in the International Communications Industries Association (ICIA), and
 - 6) Has a minimum of one full-time NICET certified Level II audio systems technician or one full-time NSCA Certified Electronics Systems Technician (C-EST), or
 - 7) Has a minimum of one ICIA CTS-I (Certified Technology Specialist – Installation) systems technician, and
 - 8) Has a fully staffed and equipped maintenance and repair facility.
- b. Testing and adjustment of equipment and systems shall be performed by qualified technicians with specific knowledge of video and audio systems alignment and trouble shooting, and knowledge of the specific equipment and systems in this project. The AVSC shall have a minimum of one full-time staff member who has a minimum of three (3) years direct experience using the test equipment and testing procedures described in this specification.
 - c. The AVSC shall have a minimum of one full-time staff member who has a minimum of three (3) years direct experience and be a factory certified programmer on the most recent version of the specified audio amplifier monitoring and control systems, integrated audio and video processing systems and technology. To ensure continuity, this programmer shall be the same individual throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.
 - d. The AVSC shall have a minimum of one full-time staff member who has a minimum of three (3) years direct experience and be a factory certified programmer of the control system software and technology. To ensure continuity, this programmer shall be the same individual throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.
- B. System Performance Requirements
1. Unless restricted by the manufacturer's published specifications of a particular piece of equipment, or otherwise required elsewhere in these specifications, the following performance standards shall be met by each system.
 2. Audio System
 - a. Systems shall provide clear, natural sound uniformly distributed throughout the listening areas. The entire electro-acoustic system shall be carefully balanced and equalized to provide a high order of intelligibility and gain without feed back or reverberant coloration. Adequate power capability shall be provided to insure the necessary dynamic range and prevent distortion at peak levels.
 - b. Electronic Frequency Response: Within ± 0.5 dB from 20Hz to 20kHz
 - c. Acoustic Frequency Response: 50 Hz to 15 kHz, 3dB/octave roll-off above 2000 Hz,, ± 2 dB. Measured at continuous one-third octave bands at seated ear height.
 - d. Sound System Coverage: as measured in accordance with ANSI/InfoComm Standard 1M-2009, "Audio Coverage Uniformity in Enclosed Listener Areas - InfoComm International Performance Standard"
 - e. Intelligibility: Greater than 0.50 STI at any seat in the audience area.
 - f. Noise: System noise shall not exceed an equivalent input noise of -120dBu based on a 20 kHz noise bandwidth. Predominant noise component in the system output under any operating condition will be that of the input stages. Adjustment of any system controls shall produce no audible clicks, pops, thumps, or other spurious noises.

- g. Acoustic Signal-to-Noise Ratio (including crosstalk and hum at all input/output levels): 60dB
 - h. Dynamic Range: The system shall deliver a minimum sound pressure level of [XX] dB with a 10 dB peaking factor to any location at seated ear height at less than 5% total acoustic harmonic distortion. When system is driven to maximum output, clipping shall first occur in the power amplifiers.
 - i. Total Harmonic Distortion: 0.05% maximum from 20Hz to 20kHz
 - j. Polarity: A positive pressure at any system microphone shall produce a positive pressure from the speakers.
3. Video System
- a. Systems shall provide, clear, bright, and natural images viewable throughout the respective designed viewing area. Each video display system shall be balanced for color and brightness and free from extraneous interference or artifacts.
 - b. Frequency Response:
 - 1) Composite: Flat from 30Hz to 6MHz, +/-2% (ref.=1MHz)
 - 2) YC: Flat from 30Hz to 10MHz, +/-2% (ref.=1MHz)
 - 3) Component: Flat from 30Hz to 100MHz, +/-2% (ref.=1MHz)
 - 4) RGBHV: Flat from 30Hz to 300MHz, +/-2% (ref.=1MHz)
 - c. Signal-to-Noise Ratio (including crosstalk and hum at all input/output levels): 60dB, p-p signal to RMS noise
 - d. Differential Gain: <2%
 - e. Differential Phase: <2 degrees at 3.58MHz
 - f. Tilt: <2%
 - g. System Gain: Unity, +/-1%
 - h. System Levels: <2% between sources
 - i. Timing: <20nS, Y/C, Y/Cr/Cb, RGB
 - j. Luminance: In conformance with NTSC RS-170A standards
 - k. Chroma level: In conformance with NTSC RS-170A standards
 - l. Observable noise or hum: None
4. Control System
- a. System stability
 - b. Control operation repeatability
 - c. Fault tolerance?
 - d. Wiring and connections
 - e. The control panel design will conform to the InfoComm International "Dashboard for Controls Design Guide", published April 2005.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Not applicable to this section.

PART 3 - EXECUTION

3.01 GENERAL

- A. Perform preliminary systems testing and adjustments in accordance with this section. Provide all personnel and equipment necessary to perform testing and adjustments.
- B. Participate in and assist with Acceptance Testing by the Engineer. This shall include listening and viewing tests, including subjective tests by observers at various positions, under various operating conditions.
- C. Make any adjustments including, but not limited to, rewiring of speaker taps, resetting of gain controls, changes in shielding or grounding, and minor changes in wiring and termination,

which are deemed necessary by the Engineer during Acceptance Testing. Such work shall be included in the base bid contract amount.

- D. Repair or replace defective equipment or installations.
- E. Prepare and submit completed AV Systems Commissioning Tests Checklist and test report for each system.
- F. Perform all work in accordance with the following safety requirements:
 - 1. Occupational Safety and Health Act.
 - 2. Accident Prevention Manual for Industrial Operations, National Safety Council.
 - 3. Applicable State and Local safety operating procedures.
 - 4. Owner's safety practices.
 - 5. ANSI/NFPA 70E, Electrical Safety Requirements for Employee Workplaces.
 - 6. American National Standards for Personnel Protection: Lockout/Tagout

3.02 TEST EQUIPMENT

- A. Test Equipment:
 - 1. Test equipment shall be in good mechanical and electrical condition.
 - 2. Non-professional test equipment or "home-built kit" equipment is not acceptable.
 - 3. The AV Systems Contractor shall have the following test equipment available on-site during the installation and testing:
 - a. Dual-trace, triggered oscilloscope with calibrated settings
 - b. Sine wave oscillator with balanced output and distortion below 0.1%
 - c. AC voltmeter with 100 milli-volt full-scale sensitivity and 50 to 10,000 Hertz frequency response
 - d. Distortion Analyzer
 - e. Sound Level Meter
 - f. One-third octave real-time spectrum analyzer, or FFT analyzer, and calibrated microphone
 - g. Pink noise generator
 - h. Calibrated RS-170A test signal generator, equivalent to Tektronix TSG-170A
 - i. Calibrated test signal device, equivalent to Tektronix 1740A
 - j. Gray-scale calibration tool equivalent to the JKP TVS Pro
 - k. Color analyzer equivalent to the Photo Research PR-650 colorimeter or Sencore CP-5000
 - l. RF signal level and frequency analyzer
 - m. Patch and jumper cables
 - n. Reference standards required for testing
 - o. Software to adjust remotely controlled signal processors, with necessary computer and related hardware. Provide sufficient cabling to permit controlling computer to be located in loudspeaker service areas while signal processors remain in equipment cabinets
- B. Test Instrument Calibration
 - 1. Testing firm shall have calibration program which assures test instruments are maintained within rated accuracy.
 - 2. Accuracy shall be directly traceable to the National Institute of Standards and Technology (NIST).
 - 3. Instruments shall be calibrated in accordance with the following frequency schedule:
 - a. Field instruments: Analog, 6 months maximum; Digital, 12 months maximum.
 - b. Laboratory instruments: 12 months.
 - c. Leased specialty equipment: 12 months where accuracy is guaranteed by lessor.
 - 4. Dated calibration labels shall be visible on test equipment.

5. Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.
6. Up-to-date instrument calibration instructions and procedures shall be maintained for test instrument.
7. Calibrating standard shall be of higher accuracy than instrument tested.

3.03 MEASUREMENTS AND PERFORMANCE TESTING

A. Audio:

1. Verify that the system is completely free from hum, noise, parasitic oscillation, and RFI.
2. Verify that positive pressure at any microphone produces positive pressure from each loudspeaker. Verify that signal polarity is correct and consistent for all circuits and paths. Reverse polarity if required, and record which circuit was reversed.
3. With signal processors in "by-pass" mode, adjust gain controls so all components except power amplifiers reach rated nominal output simultaneously. For components which have rated maximum outputs between 18 and 25dBm and line level inputs, adjust each component for unity gain.
4. Set audio distribution amplifiers for unity gain unless otherwise specified by the Engineer.
5. Adjust power amplifier input attenuators so power amplifiers reach clipping at 10dB above 0VU on the mixing console output meter.
6. Re-adjust gains if required for proper operation of each system and component. Measure and record any such re-adjustments; also record the reason adjustment was deemed necessary.
7. Measure and record the electronic signal-to-noise ratio of each complete signal path with all microphone inputs at full gain, or at gain settings which correspond to the onset of ringing for a single microphone, whichever is lower gain, and other controls at normal settings. During test, terminate microphone receptacles with 200 ohm resistors.
8. Adjust bandwidth, filter slopes, time offset correction, and signal levels of each crossover. Measure and record final settings of each unit.
9. Adjust equalizers to optimize the specified frequency responses. Measure and record the electronic frequency response and the acoustic frequency response of the system before and after adjustments.
10. Adjust time delay units to shift the apparent acoustic origin to the main loudspeakers. Measure and record delay settings for each circuit.
11. Adjust automatic mixers, automatic level controllers, and other signal processors to optimize use of microphones for speech using the expected (normal) microphone positions.
12. Measure and record the impedance of each speaker load at the main junction box or rack cabinet and total load on each amplifier. At a minimum, make measurements at 100, 1000, and 10,000 Hertz.
13. Make corrections as required so that the load impedance of each loudspeaker circuit is equal to or greater than rated load impedance of the amplifier.
14. Slowly sweep all low frequency and full range speaker systems with sine waves at 25% of rated maximum amplifier power output, or at 50% of rated continuous power capacity of loudspeakers, whichever is less, from 20 Hz to 20 kHz. Observe for audible or perceptible vibration or rattling of speaker components, mounting apparatus, or building elements. Under this Section, correct vibration or rattling of speakers or mounting apparatus to the satisfaction of the Engineer. Report vibration or rattling of other building elements to the Engineer; include frequency, characterization of observed rattling or vibration, and recommendations for correcting the rattling or vibration in the report.
15. Measure and record the maximum sound pressure level of pink noise at onset of amplifier clipping. Make measurement using both A-weighted and un-weighted (flat) settings of the Sound Level Meter (SLM).

16. Measure and record the acoustic frequency response at each location provided in the Audio Coverage Uniformity Plan (ACUP).
 17. Measure and record the speech intelligibility of the system at each location provided in the ACUP.
 18. Perform tests with the measuring microphone at the seated ear height of the audience, within designated seating areas. All interior finishes and furnishings shall be in place during measurements.
- B. Video:
1. Verify that all signals comply with the recommended manufacturer's specifications for each item of equipment.
 2. Observe each signal for AC hum or noise. Correct as required so that no hum or noise is either visible in the displayed pictures or detectable on a scope.
 3. Set signal levels to NTSC RS-170A specifications for luminance level and chroma level, gain and phase.
 4. Test signals for differential phase, differential gain, chrominance to luminance delay, multi burst frequency response and signal to noise ratio.
 5. After equipment alignment, check all signal paths from the most up-stream point in the system to verify unity gain at the final destination. Set all equalizing video distribution amplifiers to achieve correct luminance and chrominance gain at each signal destination.
 6. Measure and record initial conditions for black level, gain level, color level values, tint and gray scale values prior to making any adjustments.
 7. Measure and record final conditions for black level, gain level, color level values, tint and gray scale values after making any adjustments.

3.04 SYSTEM ACCEPTANCE TESTING

- A. When the work is complete and ready for Acceptance Testing, notify the AV Consultant in writing. Submit copies to the Architect, the AV Consultant, and the Owner. Include copies of final inspection certificates to the Owner.
- B. Include:
1. Letters from the AV Systems Contractor and all AV Subcontractors, on their respective letterheads, certifying that the AV systems are substantially complete, fully tested and adjusted, fully operational, and ready for inspection, final testing, and tuning.
 2. Preliminary System Testing and Adjustment Report
 3. Digital photographs of the completed installation. Include photographs of:
 - a. An elevation view of the front wall of each room equipped with projection screen(s), showing the screen, loudspeakers, and other system elements.
 - b. A view of each equipment room, showing the equipment racks, backboards, terminal cabinets, and other installed materials.
 - c. An elevation view of each equipment rack cabinet taken with the front door (if any) fully open, and a view of the interior of each equipment rack cabinet.
 - d. A view of each type of wall-mounted device, including cameras, monitors, control panels, etc.
 - e. A view of each type of ceiling-mounted device, including loudspeakers, etc.
 - f. Close-up views of each type of input panel and output panel.
 - g. Close up views of each type of floor box/pocket with the covers open, and with the covers closed.
 - h. Professional photographs are not required; color "snapshots" with minimum size of 3" by 5" is acceptable. Photographs shall be legible, well lighted, and well focused, and composed to fill the image with the intended subject as much as possible.
 4. List of discrepancies and corrective action taken.
- C. Acceptance Testing

1. The Engineer will schedule its site visit once the AV Systems Contractor's completion report has been submitted and approved. Allow at least 10 calendar days between receipt of Completion Report by Engineer and the earliest desired date for site visit by Engineer.
 2. The AV Systems Contractor will assist the Engineer in performing acceptance tests, equalization, and other system adjustments.
 3. All final, "as-built" drawings, run sheets, manuals, and other required documents shall be on hand.
 4. Manuals: All manufacturers' maintenance, service, and alignment manuals shall be present during testing and adjustment procedures.
 5. System Acceptance Tests will be supervised by the Consultant and will consist of the following:
 - a. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents.
 - b. The operation of all system equipment shall be demonstrated by the AV Systems Contractor.
 - c. The operation of the control systems/touch panels will be reviewed for acceptance by the Owner.
 - d. Listening and viewing tests, including subjective tests by observers at various positions, under various operating conditions.
 - e. A random verification of measurements submitted with the Preliminary System Testing and Adjustment Report.
 - f. Final adjustments to signal processors and system gain settings.
 6. The Contractor shall provide on-site personnel who performed the installation and testing.
 7. Contractor shall make any adjustments, including but not limited to re-wiring of speaker taps, resetting of gain controls, changes in shielding or grounding, and minor changes in wiring and termination, which are deemed necessary by the Engineer. Such work shall be included in the base bid contract amount.
- D. Additional Site Visits
1. Additional site visits may be deemed necessary by the AV Consultant if any of the following conditions are found during the acceptance testing site visit:
 - a. Items of equipment which are missing or non-operational.
 - b. Items of equipment which do not meet the specifications or the manufacturers published performance criteria.
 - c. Hum, buzz, or noise which degrades the signal to noise ratio of any circuit by more than 5 decibels from the manufacturers' rated signal-to-noise ratios for the upstream components.
 - d. Audio distortion which is audible or video distortion which is visible.
 - e. Any other conditions which are not in accordance with the specifications, drawings, AV Systems Contractor's submittals, or Preliminary System Testing and Adjustment Report.
 2. In the event further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the Engineer.
 3. The AV Systems Contractor shall make every possible effort to correct the deficiencies during the site visit to avoid additional site visits.
 4. The AV Consultant will render reasonable assistance to avoid additional site visits, including extending the site visit, so long as it does not hamper other work of the site visit.
 5. Any charge for additional time incurred by the Consultant required to observe system tests due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to, the AV Systems Contractor.
 6. If additional site visits are deemed necessary:

- a. The Consultant will submit a written notification of the reasons with descriptions of the deficiencies to be corrected.
- b. Under this Section, with no increase in the Contract amount, the AV Systems Contractor shall pay for the additional site visits by the Consultant, in the form of reimbursement to the Owner or Architect for their actual cost of services by AEI NW. AEI NW will bill the additional services for the additional site visit(s) at its prevailing standard hourly rates for time (including travel time), plus actual costs for travel, per diem, and related expenses.

3.05 CLEANING

- A. Leave installations clean and premises free from residue and debris from work of this Section.

3.06 ATTACHMENTS

- A. 27 08 00A - AV Systems Commissioning Checklist

END OF SECTION

SECTION 27 1000 STRUCTURED CABLING

PART 1 - GENERAL

1.01 SCOPE

- A. This section details product and execution requirements for Structured Cabling for Communications Systems.

1.02 DESCRIPTION

- A. Systems shall include cabling, termination hardware and active components, installed as indicated on drawings and specifications.
- B. Cables and equipment shall be provided, tested, and terminated, including proper grounding and bonding.
- C. **[Work also includes removal and recycling of unused, undocumented and otherwise "abandoned" cables as identified in Part 3 of this Section.]**

1.03 RELATED WORK

- A. Related Division 27 Sections include:
 - 1. Section 27 0000 - General Communications Requirements
 - 2. Section 27 0526 - Grounding and Bonding for Communications Systems
 - 3. Section 27 0528.29 - Hangers and Supports for Communications Systems
 - 4. Section 27 0528.33 - Raceway and Boxes for Communications Systems
 - 5. Section 27 0528.36 - Cable Tray for Communications Systems
 - 6. Section 27 0528.39 - Surface Raceways for Communications Systems
 - 7. Section 27 0553 - Communications Systems Identification
 - 8. Section 27 1100 - Communications Equipment Room Fittings
 - 9. Section 27 1300 - Communications Backbone Cabling
 - 10. Section 27 1500 - Communications Horizontal Cabling
 - 11. Section 27 1600 - Communication Connecting Cords, Devices and Adapters
 - 12. Section 27 5150 - Master Antenna Television Systems
 - 13. Section 27 5223 - Nurse Call System
- B. Related sections in other Divisions of Work:
 - 1. Refer to individual technical sections identified above (if applicable).

1.04 REFERENCES AND STANDARDS

- A. Refer to Section 27 0000 - General Communications Requirements which identifies pertinent References and Standards.
- B. In addition:
 - 1. TIA 568.0-D through 4-D - Commercial Building Telecommunications Cabling Standard (including applicable Addenda)
 - 2. TIA 569-E598 - Commercial Building Standard for Telecommunications Pathways and Spaces.
 - 3. BICSI Telecommunications Distribution Methods Manual (TDMM)
 - 4. **[TIA-758-B - Customer-Owned Outside Plant Telecommunications Infrastructure Standard]**
 - 5. **[TIA-862-B - Structured Cabling Infrastructure Standard for Intelligent Building Systems]**
 - 6. **[TIA-942-B - Telecommunications Infrastructure Standard for Data Centers]**
 - 7. TIA-598-D: Optical Fiber Cable Color Coding.
 - 8. TIA 455-21-A: Mating Durability for Fiber Optic Interconnecting Devices
 - 9. TIA 526-14-C: Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - 10. TIA-526-7-A: Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant

11. UL-910: Tests for Flame Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables used in Spaces Transporting Environmental Air
12. UL-1666: Tests for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
13. IEEE 802.3af and 802.3at Power-over-Ethernet Standards.
14. IEEE 802.3an 10 Gigabit Standard

1.05 DEFINITIONS

- A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.
- B. In addition, the following definitions are applicable to communications environments and shall apply to this document and its companion sections for clarification and direction:
 1. Backbone Cabling - cable or conductors between telecommunications rooms, or floor distribution terminals, entrance facilities, and equipment rooms within or between buildings. Backbone cabling may be twisted pair copper, fiber optic or coaxial.
 2. Cable - assembly of 1 or more conductors or optical fibers within enveloping sheath, constructed so as to permit use of conductors singly or in groups.
 3. Cable ID - unique alpha-numeric identification used for tagging of backbone or horizontal cabling.
 4. Channel - end-to-end transmission path to which application-specific equipment is connected. Same as "Permanent Link", but also includes patch cords at Telecommunications Outlet and in Telecom Room.
 5. Consolidation Point (CP): A location for interconnection between horizontal cables extending from the horizontal cross-connect and horizontal cables extending to the telecommunication outlet at the workstation.
 6. Contractor: Telecommunications Contractor or sub-contractor(s) responsible for installation, termination, test and documentation of communications cabling, termination components, pathway hardware, telecommunications equipment room hardware and related components detailed in technical sections of this Division of work.
 7. Cross-Connect - group of connection points between cabling runs and/or equipment used to administer building wiring using patch cords or wire jumpers.
 8. Horizontal Cabling - Cables connecting Telecommunications Outlets to horizontal or intermediate cross-connect. Sometimes referred to as "Station Cabling".
 9. Horizontal Cross-connect (HC) – Connection of horizontal cabling to other cabling (e.g. horizontal, backbone or equipment) using patch cords or wire jumpers.
 10. Interconnection - Connection scheme using connecting hardware for the direct connection of a cable to another cable without a patch cord or jumper
 11. Main Cross-connect (MC) – Connection between backbone cables, entrance cables and equipment cables using patch cords or wire jumpers.
 12. Outlet ID - unique alpha-numeric identification used for referencing Telecommunications Outlet or connectors therein.
 13. Permanent (Cable) Link - includes Telecommunications Outlet, horizontal (station) cable and termination hardware in Telecom Room.
 14. Service Loop - Surplus cable, typically located at or near point of termination to enable future changes.
 15. Telecommunications Outlet (TO) - device assembly located in work area on which horizontal cabling terminates and which can receive modular connectors. It is interface between Station Cable and end user's equipment.
 16. Telecom Room - an enclosed space for housing telecommunications equipment, horizontal and backbone cable terminations, and cross-connect cabling, that is recognized location of horizontal cross-connect.

17. Zone Box - An enclosure used to house one or more of the following; a) a consolidation point, b) a horizontal connection point, c) building automation system outlets.
18. Zone Cabling - Extends permanent horizontal cabling to a shared termination (consolidation) point in the work area. Passive system extends link to workstation through at interconnect at the Consolidation Point (CP). Active system includes system electronics at the CP.
- C. "10-gigabit" or "10G" performance criteria, if applicable, refers to support of 10GBASE-T application over 4-connector channel up to 100 meters and meeting requirements of TIA-568-C.2.
- D. The following definitions are specific to the Project environment and shall apply to this document and its companion sections for clarification and direction.
 1. [ENTER]

1.06 ABBREVIATIONS AND ACRONYMS

- A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.
- B. In addition, the following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction:
 1. 8P8C Eight-Position, Eight-Conductor. Used in clarifying jack type; a.k.a. "RJ-45".
 2. CM Communications cable rated for General Purpose use
 3. CMP Communications cable rated for use in Plenum areas
 4. CMR Communications cable rated for use in Risers and vertical runs
 5. CP Consolidation Point
 6. ELFEXT Equal-Level Far-End Cross Talk (pair-to-pair)
 7. FEXT Far-End Cross Talk
 8. F/UTP Foiled Unshielded Twisted Pair
No shielding around individual pairs and an overall foil shield under the cable jacket
 9. HC Horizontal Cross-connect
 10. HCP Horizontal Connection Point (e.g. for TIA-862)
 11. IDF Intermediate Distribution Frame
 12. MC Main Cross-connect
 13. MDF Main Distribution Frame
 14. MPTL Modular Plug Terminated Link
 15. NNewton
 16. NEXT Near End Cross Talk
 17. OFNP Optical Fiber Nonconductive Plenum
 18. OFNR Optical Fiber Nonconductive Riser
 19. OTDR Optical Time Domain Reflectometer
 20. PBX Private Branch Exchange (Telephone Switch)
 21. PoE Power-over-Ethernet
 22. PSNEXT Power Sum Near End Cross Talk
 23. S/FTP Screened Foiled Twisted Pair
(Individual foil shield around each individual pair and an overall braided shield under the cable jacket.)
 24. S/UTP Screened Unshielded Twisted Pair
(No shielding around individual pairs and an overall braided shield under the cable jacket.)

- 25. SF/UTP Screened Foiled Unshielded Twisted Pair
(No shielding around individual pairs and overall foil and braided shields under the cable jacket.)
- 26. TO Telecommunications Outlet
- 27. TR Telecommunications Room
- 28. USOC Universal Service Order Code
- 29. UTP Unshielded Twisted Pair
(No shielding around pairs nor overall under cable jacket.)
- 30. U/FTP Unshielded Foiled Twisted Pair
(Individual foil shield around each individual pair and no overall braided shield under the cable jacket.)

1.07 WORK BY OWNER

- A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.08 SUBMITTALS

- A. Refer to Section 27 0000 - General Communications Requirements which provides general guidelines for product or installation information to be submitted by Contractor.
- B. In addition, Submit:
 - 1. Contractor Certification documents which document their participation in Installers Program operated by Manufacturer of Cabling or Termination Components used.
 - a. Upon request, Certified Installer(s) assigned to Project shall be identified to Engineer.
 - 2. Meeting agenda for Pre-Construction Coordination Meeting

1.09 QUALITY ASSURANCE

- A. General:
 - 1. Cable and Equipment Manufacturer(s) shall be company specializing in communications cable, accessories and/or equipment with minimum of 5 years documented experience in producing cable, accessories and/or equipment similar to those specified herein.
- B. Contractor Qualifications:
 - 1. Qualified personnel utilizing state-of-the-art equipment and techniques shall complete cable and equipment installation and termination.
 - 2. Contractor shall have been in this business for minimum of 5 years and shall have successfully completed **[4] [quantity]** projects **[equal in] [50% of]** magnitude of system specified in the following sections.
- C. Contractor shall have necessary certifications to provide for Warranty as specified herein.
 - 1. Contractor shall be an active participant in Installers Program operated by Manufacturer of Cabling or Termination Components used.
 - a. Contractor shall be participant in this program at time of Bidding and remain so throughout project.

1.010 GUARANTEE

- A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents and Section 27 0000 - General Communications Requirements for general guarantee requirements.
- B. Warranty structured cable system as follows:
 - 1. 4-pair Category-rated Horizontal Copper **[Permanent Link] [Channel]** for no-less than **[20] [XXX]** years from date of substantial completion of work.
 - 2. Copper Backbone for no-less than **[2] [XXX]** years from date of substantial completion of work. Cabling and Connecting Components shall carry **[20] [XXX]** yr component warranty.

3. Fiber Optic Backbone for no-less than **[20] [XXX]** years from date of substantial completion of work.

C. Warranty shall be direct from manufacturer(s) of cabling and connecting components to Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. Refer to individual Technical Sections.

2.02 POWER OVER ETHERNET

A. All cable and connecting components that comprise the TIA horizontal cabling "Permanent Link" from Horizontal Cross-connect to Telecommunications Outlet shall be compliant with the applicable requirements for "DTE Power via the MDI" to provide at least **[25.5W][51W][71W]** at the Powered Device as defined by the **[IEEE 802.3at][IEEE 802.3bt]** standard.

B. **[Cabling shall be UL-LP listed at a minimum of 0.5A.]**

C. Connecting hardware shall comply with IEC 60512-99-**[002][001]** for engaging and separating connectors under electrical load and connectors used in twisted pair communication cabling with remote power.

2.03 SYSTEM REQUIREMENTS

A. Structured cabling products shall be designed to work together as a fully-warranted system.

B. Acceptable Category 6 systems shall be:

1. Belden REVConnect 2400
2. CommScope SYSTIMAX GigaSPEED XL
3. Hubbell Premise Wiring NEXTSPEED 6
4. Leviton CX6200 Cat 6 Premium UTP System
5. Panduit Enhanced Category 6 System (Panduit cable only)
6. Siemon Premium 6 Z-MAX

C. Acceptable Category 6A systems shall be:

1. Belden REVConnect 10GX12
2. CommScope SYSTIMAX GigaSPEED X10D
3. Hubbell Premise Wiring NEXTSPEED 6A
4. Leviton CX6700 Cat 6A Enhanced+ UTP System
5. Panduit Category 6A MaTriX system (Panduit cable only)
6. Siemon Z-MAX 6A

PART 3 - EXECUTION

3.01 PRE-CONSTRUCTION COORDINATION MEETING

A. Prior to preparing and submitting submittals, Contractor shall arrange and conduct a pre-construction coordination meeting to review and coordinate Structured Cabling requirements.

1. Attendees shall include:

- a. Owner's project manager and Information Technology / Information Services representative(s)

Coordinate group names above to match names used for each project/client. Division 27 Engineer

- c. Construction Manager / General Contractor project manager and site superintendent / field foreman
- d. Division 27 project manager and site superintendent / field foreman
- e. Structured Cabling contractor project manager and site superintendent / field foreman, if different from Division 27 personnel
- f. Division 26 project manager and site superintendent / field foreman
- g. **[Project Architect and Architectural Construction Field Rep]**
- h. **[LIST OTHER REQUIRED ATTENDEES AS APPLICABLE PER PROJECT]**

2. Meeting agenda topics shall include:
 - a. Review and coordinate details of Structured Cabling scope, including:
 - 1) CABLE LABELING SCHEMES
 - 2) DIMENSIONED TELECOM ROOM LAYOUTS
 - 3) TELECOM RACK LAYOUTS DIMENSIONED IN RACK UNITS
 - 4) COLOR SCHEMES FOR:
 - A) TELECOM OUTLET CABLING
 - B) TELECOM OUTLET JACKS
 - C) TELECOM OUTLET FACEPLATES
 - 5) WIRELESS ACCESS POINT TELECOM OUTLET REQUIREMENTS
 - 6) **[COMMUNICATIONS CONNECTING CORD REQUIREMENTS]**
 - b. Coordinate division of work among trades.
 - c. Review construction schedule and identify milestones related to Structured Cabling **[including telecom room turnover dates, test results submittal.]**
3. Schedule meeting with minimum two weeks' notice.
 - a. Publish agenda for meeting and distribute to invited attendees when meeting is scheduled.
4. Contractor shall take detailed notes during meeting and publish meeting notes within one week after meeting.
 - a. Contractor shall distribute notes to invited attendees and Architect.

3.02 GENERAL

- A. Refer to individual technical specification sections for detailed Cable Routing and Installation, Testing and Documentation requirements. The following apply to communications cabling and termination work.
- B. Installation shall be per manufacturers' recommendations.
- C. Label cables and termination components per Section 27 0553 - Communications Systems Identification.

3.03 REMOVAL AND RECYCLING OF ABANDONED CABLE

- A. Remove and recycle unused, undocumented and otherwise "abandoned" cables prior to the completion of the project.
 1. Definition of Abandoned Cable is contained in NEC 2002 Articles: 640, 645, 725, 760, 770, 800, 810, 820 and 830. Further definition is contained in NFPA-75, NFPA-76 and NFPA-90A.
- B. **[ADD Language describing the extent of the cabling to be removed.]**
- C. **[Owner]** shall be available to assist in the identification of these cables.

3.04 CABLE INSTALLATION

- A. Run cabling in raceways provided, or as designated on floor plans, and support from building structure.
 1. Where installed in free-air, support cables using J-hook type cable supports installed in accordance with manufacturer's installation requirements. Refer to Section 27 0528.29 - Hangers and Supports for Communications Systems for installation requirements.
 - a. J-hook fill capacities shall be per manufacturer's recommendations and shall consider diameter of cable type(s) being installed.
 - b. Route cable/hooks at right angles, parallel to construction.
 2. Where installed in Cable Tray, lay cables neatly in tray.
 - a. **[Do not tie.] [Secure cable bundles using hook and loop ties at [XXX]ft intervals].**
 - b. **Provide sufficient slack in cables to allow for unequal expansion coefficients of cable tray and cables. This requirement is in addition to slack required at cable tray expansion joints.**

- B. Route and support cable in Equipment Rooms and Telecom Rooms utilizing "D-type" mounting rings, J-hooks and overhead cable runway.
- C. Cable shall be free of tension at both ends.
 - 1. In cases where cable must bear stress, provide Kellems grips to spread stress over longer length of cable.
- D. Provide required installation tools to facilitate cable pulling without damage to cable jacket.
- E. Keep cables clear of other trades work.
- F. During pulling operation provide an adequate number of workers to allow cable observation at points of raceway entry and exit, as well as to feed cable and operate pulling machinery.
- G. Pull cables in accordance with cable manufacturer's recommendations and ANSI/IEEE C2 Standards.
- H. Pull cable by hand unless installation conditions require mechanical assistance.
- I. Do not exceed recommended pulling tensions and bending radii.
 - 1. Where mechanical assistance is used, ensure that maximum tensile load for cable is not exceeded.
 - a. This may be in form of continuous monitoring of pulling tension, use of "break-away" or other approved method.
 - 2. Replace cables bent or kinked to radius less than recommended dimension.
 - a. This shall be at no expense to Owner.
- J. Install cables splice-free unless otherwise specified.
- K. Avoid abrasion and other damage to cables during installation.
 - 1. Visually inspect cables for cuts, blisters and abrasions during installation.
- L. Pulling lubricant may be used and shall:
 - 1. Be non-injurious to cable jacket and other materials used.
 - 2. Not harden or become adhesive with age.
- M. Repair damage to interior spaces caused by installation of cable, raceway or other hardware. Repairs must match preexisting color and finish of walls, floors and ceilings.
- N. Replace contractor-damaged ceiling tiles to match color, size, style and texture.
- O. Provide pull cord (200 lb minimum) with cable installed in conduit or innerduct.
- P. Neatly lace, dress and support cabling.
- Q. In vertical pathway, support cables on each floor using industry recognized support methods designed specifically for that purpose.
 - 1. Strap vertical runs as required, to prevent sagging of cables.
- R. To reduce effects of EMI, adhere to the **[following]** minimum cable separation distances^[:] **defined in TIA-569-E.]**
 - 1. **5" from power lines of 2 kVA**
 - 2. **18" from high voltage lighting (including fluorescent and LED)**
 - a. When using LED lighting, stated separation distance shall be from cables to LED drivers.
 - 3. **39" from power lines of 5 kVA or greater**
 - 4. **47" from transformers and motors]**

3.05 FIELD TESTING

- A. Refer to Section 27 0000 - General Communications Requirements for general guidelines regarding requirements for scheduling and performing compliance testing.
- B. Cabling shall be 100% fault free unless otherwise noted. If any **[Link]** **[Channel]** is found to be outside specification defined herein, identify and correct problem up to and including replacement of cable and associated termination(s). Then repeat applicable tests.
- C. Test each cabling sub-system (e.g. backbone, horizontal, etc.) end-to-end.
- D. Where sub-systems are to be interconnected or cross-connected by the contractor, test individual sub-system followed by a test of the connected links

1. Performance and documentation requirements shall default to the lesser of the two connected systems if different.
2. Example 1: Combined Backbone-Horizontal Link
 - a. Test and document individual Backbone and Horizontal Cabling Sub-systems.
 - b. Cross-connect sub-systems.
 - c. Repeat testing on combined cabling from MC - TO through HC.
 - d. Performance and documentation requirements shall be based in this example on backbone cabling (continuity, pair integrity, etc.).
3. Example 2: Interconnected Zone Cabling Link
 - a. Test and document individual HC – CP links.
 - b. Install interconnect cabling CP – TO
 - c. Repeat testing on combined cabling from HC – TO through CP.
 - d. Performance and documentation requirements shall be based in this example on TIA Permanent Link for Horizontal Cabling.
- E. Test instrument shall be configured using template for exact cable under test (e.g. by manufacturer product designation).
 1. If no template is available, enter cable parameters for the cable per manufacturer's product data.
 - a. Nominal Velocity of Propagation (NVP) used for copper cable type under test shall be traceable to manufacturers' product data.
 - b. Refractive Index used for fiber optic cable type under test shall be traceable to manufacturers' product data.
 2. Test results obtained using incorrect cable parameters will be rejected.
- F. Test instrument shall be calibrated as defined by instrument manufacturer at least once every 12 months **[or as required by test instrument manufacturer if that results in more frequent calibration runs]**.
 1. Test instrument calibration date shall be present in test results documentation.
- G. Refer to individual Technical Sections for system-specific guidelines regarding requirements for scheduling and performing compliance testing.

3.06 DOCUMENTATION

- A. Refer to Section 27 0000 - General Communications Requirements for general guidelines regarding requirements for project Documentation.
- B. Refer to individual Technical Sections for system-specific guidelines regarding requirements for project Documentation.
- C. Information added by Contractor to Record Drawings shall include:
 1. Backbone and horizontal cable routes
 2. Telecommunications outlet locations and identification
 3. Other detail necessary to document cable installation

3.07 OWNER TRAINING

- A. Provide training for Owner's personnel on operation and maintenance of total system and each component.
- B. Training to include:
 1. Overview of System Topology and General Concepts
 2. Overview of Product Used
 3. Overview of Equipment Room Layouts
 4. Overview of Labeling Formats
 5. Overview of Test Results and their meaning
 6. Overview of Documentation

- C. Training shall be held at **[Project Site][Other]** and shall be conducted during normal working hours.
- D. Training session duration shall be not less than **[one (1) h][X h]**.
 - 1. Provide **[(1)][Qty]** such sessions.
 - 2. Coordinate with owner to schedule session(s). Provide adequate notification to allow owner to schedule staff.
- E. Attendance shall be by owner staff **[and/or contract maintenance personnel]**.
 - 1. Number of Students per session shall be **[6][XXX]**.
 - 2. Materials shall be provided for the number of students indicated.
- F. Provide example course materials and instructor background in advance of training session(s).
- G. Owner may videotape session(s) for use as future refresher materials for owner technical staff.

END OF SECTION

**SECTION 27 1100
COMMUNICATIONS EQUIPMENT ROOM FITTINGS**

PART 1 - GENERAL

1.01 SCOPE

- A. This section details product and execution requirements for Communications Equipment Room Fittings for Communications Systems.

1.02 DESCRIPTION

- A. Communications Equipment Room Fittings include:
1. **[Cabinets, Racks, Frames and Enclosures]**
 2. **[Cable Runway]**
 3. **[Termination Blocks]**
 4. **[Patch Panels]**
 5. **[Entrance Protection]**
 6. **[Power Strip/Surge Suppressor]**
- B. Refer to Project Drawings for Equipment Room layout and equipment placement.

1.03 RELATED WORK

- A. Refer to Section 27 0000 - General Communications Requirements which identifies related specification sections in this and other Divisions (if applicable).

1.04 REFERENCES AND STANDARDS

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.
- B. Related Division 27 Sections include:
1. Section 27 0000 - General Communications Requirements
 2. Section 27 0526 - Grounding and Bonding for Communications Systems
 3. Section 27 0528.29 - Hangers and Supports for Communications Systems
 4. Section 27 0528.33 - Raceway and Boxes for Communications Systems
 5. Section 27 0528.36 - Cable Tray for Communications Systems
 6. Section 27 0528.39 - Surface Raceways for Communications Systems
 7. Section 27 0548 - Vibration and Seismic Controls for Communications Systems
 8. Section 27 0553 - Communications Systems Identification
 9. Section 27 1000 - Structured Cabling
 10. Section 27 1300 - Communications Backbone Cabling
 11. Section 27 1500 - Communications Horizontal Cabling
 12. Section 27 1600 - Communication Connecting Cords, Devices and Adapters
 13. Section 27 5150 - Master Antenna Television Systems
- C. Related sections in other Divisions of Work:
1. Refer to individual technical sections identified above (if applicable).

1.05 DEFINITIONS

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Definitions used in this and related sections.

1.06 ABBREVIATIONS AND ACRONYMS

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Abbreviations and Acronyms used in this and related sections.

1.07 WORK BY OWNER

- A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.08 SUBMITTALS

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide general guidelines for product or installation information to be submitted by Contractor.

1.09 QUALITY ASSURANCE

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identify general quality assurance requirements for the Project.

1.010 GUARANTEE

- A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.
- B. Refer to Section 27 1000 - Structured Cabling for particular Warranty requirements for Structured Cabling. Those requirements apply to cable and components covered in this section.

PART 2 - PRODUCTS

2.01 CABINETS, RACKS, FRAMES AND ENCLOSURES

- A. Manufacturers: Rittal, CPI, Ortronics, Wrightline, Panduit, Damac or Siemon
- B. Equipment racks shall be:
 - 1. Constructed of **[painted][anodized]** aluminum
 - 2. **[Color Black][Color Gray][Clear Coated]**
 - 3. Supplied with ground bar (19" wide by 1" high) and #6 AWG ground lugs
 - 4. Supplied with minimum of 12 releasable cable support ties (e.g. "hook and loop")
 - 5. Supplied with spare screws (minimum of 50)
 - 6. Configured with Channel uprights spaced to accommodate industry standard 19" mounting
- C. Free Standing Equipment Rack shall comply with general requirements above and shall:
 - 1. Be 84" in height
 - a. Have minimum of **[45][XXX]** usable rack mounting units (RU)
 - 2. Be self-supporting
 - 3. Have Minimum base footprint of 15" x 20"
 - 4. Be double-sided drilled and tapped to accept 12-24 screws
 - a. Uprights shall be drilled on back to accept cable brackets, clamps, power strip(s).
 - b. Hole pattern on rack front and back shall be per EIA/TIA specifications (5/8" – 5/8" – 1/2").
- D. Wall Mounted Equipment Rack shall comply with general requirements above and shall:
 - 1. Be 48" in height
 - a. Have minimum **[XXX]** usable rack mounting units (RU)
 - 2. Be minimum **[18"] [XXX]** deep from front face of vertical rails to wall behind
 - 3. Be double-side drilled and tapped to accept 12-24 screws
 - a. Uprights shall be drilled on back to accept cable brackets, clamps, power strip(s).
 - b. Hole pattern on rack front and back shall be 5/8" – 5/8" – 1/2".
- E. Equipment Cabinets
 - 1. **[ENTER TEXT]**
- F. Cable Management
 - 1. Manufacturers: Rittal, CPI, Wrightline, CommScope, Ortronics, Panduit or Siemon
 - 2. Horizontal Cable Management Panels shall:
 - a. Be painted steel
 - b. Be 3.5" high
 - c. Have minimum of 5 distribution rings (3.75" x 3.75" minimum dimension)
 - 1) DISTRIBUTION RINGS SHALL BE **[PLASTIC] [PAINTED STEEL]**

- d. **[Incorporate cable routing guides and supports on rear of panel.]**
3. Vertical Cable Management shall:
 - a. Provide for cable routing on front and rear of each rack
 - b. Be **[5"] [8"] [12"]** wide (minimum) when installed between two racks
 - c. Be **[4"] [6"] [8"]** wide when installed at end of rack row
 - d. **[Incorporate cable slack spools.]**
 - e. Mount on spacers attached to rack uprights and not on upright
 - f. Be accessible from front and rear of rack
 - g. Be designed to space slots/fingers at 1 RU intervals to align with rack-mounted equipment
- G. Equipment Rack Ground **[Busbar][Strip]**
 1. Material: Copper
 2. Mounts **[horizontally in rack][vertically on rack upright]**
 3. Mounting configuration EIA universal mounting hole pattern **[, tapped #12-24.][Uses self-tapping screws.]**
- H. Miscellaneous
 1. Releasable Cable Support Ties shall be:
 - a. Hook & Loop type
 - b. Individual units with latch
 - 1) ROLL OF HOOK & LOOP MATERIAL IS NOT ACCEPTABLE.

2.02 CABLE RUNWAY

- A. Manufacturers: CPI, B-Line
- B. Cable Runway shall:
 1. Be constructed of 0.065" thick steel
 2. Utilize tubular stringers to support rungs.
 - a. Stringers shall be 1-1/2" high.
 - b. Rungs shall be welded to stringers and shall be spaced 9" on center.
 3. Be painted with **[black epoxy] [gray epoxy]**.
- C. Runway width(s) shall be as shown on drawings.

2.03 TERMINATION BLOCKS

- A. Manufacturers: Refer to System Requirements list in 27 1000
- B. Blocks shall be 110-style high-density cross-connect blocks.
- C. Each horizontal row of block shall be capable of terminating one 25 pair binder group of Backbone Copper Cable, or six 4 pair Copper Cables.
- D. Mechanical termination on blocks shall:
 1. Have ability to terminate 22-26 AWG plastic insulated, solid and stranded copper conductors.
 2. Provide direct connection between horizontal or backbone cable and jumper wires.
 3. Be designed to maintain cable pair twists as closely as possible to point of mechanical termination.
- E. Blocks for Horizontal Cabling shall use 4-pair connecting blocks; blocks for backbone cabling shall use 5-pair connecting blocks.
 1. Blocks shall identify pair position by color designation.
 - a. Colors shall be Blue, Orange, Green and Brown for Horizontal Cables.
 - b. Colors shall be Blue, Orange, Green, Brown and Slate for Backbone Cables.
 - c. Markings shall designate Tip and Ring conductors.
- F. Horizontal Voice Blocks shall:
 1. Be **[rack] [wall]**-mounted with **[legs] [no legs]**
 2. Meet or exceed TIA **[Category 3] [Category 5e] [Category 6]** performance criteria

3. Terminate up to **[100] [300]** pairs (each block)
- G. Horizontal Data Blocks shall:
 1. Be **[rack] [wall]**-mounted with **[legs] [no legs]**
 2. Meet or exceed TIA **[Category 5e] [Category 6]** performance criteria
 3. Terminate up to **[100] [300]**-pairs (each block)
- H. Backbone Voice Blocks shall:
 1. Be **[rack] [wall]**-mounted with **[legs] [no legs]**
 2. Meet or exceed TIA **[Category 3] [Category 5e]** performance criteria
 3. Terminate up to **[100] [300]** pairs (each block)
- I. System Terminal Blocks shall:
 1. Be **[wall] [rack]**-mounted with **[legs] [no legs]**.
 2. Meet or exceed TIA **[Category 3] [Category 5e]** performance criteria.
 3. Terminate up to **[100] [300]** pairs (each block).
 4. Be pre-wired in 5-pair increments utilizing 25-pair tails wired to each base.
 - a. Tail length shall be **[6"] [XXX]**
 - b. Tails shall be terminated in **[female] [male]** 50-pin telco ("Amphenol" or "RJ-21") connectors.
 - c. Tails shall exit from **[bottom] [top]** of block.
 - d. Blocks shall be factory tested.
 - e. Factory terminated cables shall utilize 5-pair connecting blocks with standard Backbone Voice Cable color designation.
- J. Horizontal Cable Managers (Jumper Troughs) designed for use with blocks shall be:
 1. Manufactured with high-strength, flame-retardant thermoplastic
 2. Designed for easy cable insertion or withdrawal
 3. 2 RUs high
 4. Rack- or wall-mountable (with legs) to match block configuration
- K. Horizontal Cable Managers designed for use at top of column of blocks shall be 188B type. 188B type cable manager shall:
 1. Be constructed of metal with two plastic distribution rings
 2. Have legs to allow space for routing cables behind Backboard
 3. Have dimensions 6.5" high x 10.7" wide
- L. Vertical Cable Managers for wall-mounted Termination Blocks shall utilize distributing rings.
 1. Rings shall be **[metal] [plastic]** and be split to facilitate passage of jumper wires.
 2. Minimum Dimension of each ring shall be 5" square (minimum).

2.04 MODULAR PATCH PANELS

- A. Manufacturers: Refer to System Requirements list in 27 1000
- B. Panels shall:
 1. Consist of Modular-to-IDC connector system
 2. Be rack-mountable in standard EIA 19" equipment racks
 3. Be 2 RUs high
 4. Accommodate 48-port modular jacks in two rows of 24-ports
 5. Be designed to terminate 4-pair, 100-Ohm **[UTP] [F/UTP]** cables
 - a. **[Panels designed to terminate F/UTP cable shall achieve shield continuity by using ground clip or spade, and provide 2 ground lugs]**
 6. Have ability to terminate 22-26 AWG plastic insulated, solid and stranded copper conductors.
 7. Be designed to maintain cable's pair twists as closely as possible to point of mechanical termination.
 8. Have cable support and strain relief devices to secure cables at IDC connector.

- a. Panel and cable support hardware shall ensure that cabling minimum bend radius requirements are satisfied.
- 9. Have port identification numbers on both front and rear of panel.
- 10. Have color-coded pair designations on rear of panel.
- C. Modular Jacks in Panel shall:
 - 1. Be non-keyed, 8 position, 8-conductor (8P8C)
- D. Panels shall meet or exceed **[TIA Category 5e] [TIA Category 6] [TIA Category 6A]** performance criteria.

2.05 FIBER OPTIC PATCH PANELS

- A. Manufacturers: Corning, Siemon, Panduit or Ortronics.
- B. Patch Panels shall:
 - 1. Be enclosed assemblies
 - 2. Incorporate hinged or retractable front cover
 - 3. Be rack mountable on standard TIA 19" equipment racks
 - 4. Provide for strain relief of incoming cables
 - 5. Incorporate radius control mechanisms to limit bending of fiber to manufacturer's recommended minimums of 1.2", whichever is larger
 - 6. Provide protection to both "facilities" and "user" sides of couplings.
 - 7. Be configured to require only front access when patching
 - 8. Incorporate patch cable routing space internal to patch panel enclosure.
 - a. Routing space shall be front-accessible.
 - 9. Include provisions for permanent labeling of fiber optic cables.
 - a. Labeling shall be accessible from front of patch panel and shall not require disassembly of patch panel enclosure or removal of front cover.
- C. Couplings shall be mounted on assembly that snaps into patch panel enclosure.
 - 1. This assembly shall be designed to accept variety of coupler types including, ST, SC, duplex SC and high-density mini-connectors.
 - 2. Coupling type shall be **[ST-type] [duplex SC] [duplex LC]**
 - 3. Coupling Color shall be as follows:
 - a. Multimode: BEIGE
 - 1) EXCEPTION: LASER-OPTIMIZED 50/125 MULTIMODE COUPLINGS SHALL BE AQUA
 - b. Single-mode: BLUE
- D. Access to inside of panel enclosure during installation shall be from front and rear.
 - 1. Panels that require disassembly of cabinet to gain entry will not be accepted.
- E. Incoming cables shall not be accessible from patching area of panel.
 - 1. Enclosure shall provide physical barrier to access of such cables.
 - 2. Where factory-terminated cable assemblies ("pigtailed") are spliced to cable, enclosure shall incorporate hardware for securing of splice tray and required cable, buffer tube and pigtail slack.

2.06 ENTRANCE PROTECTION

- A. Manufacturers: Corning, Porta Systems, CommScope, Circa
- B. Interface on Protection devices shall be as follows:
 - 1. Input: **[110-type block] [cable stub; 26 AWG]**
 - 2. Output: **[110-type block] [cable stub]**
- C. **[Unit shall be equipped with an internal fuse link.] [26 AWG cable stub shall act as fuse link.]**
- D. Entrance protection shall:
 - 1. Be listed primary protector

2. Accommodate industry standard 5 pin protection modules
3. Be provided with grounding lug
- E. Covers on protector housing **[are not required.] [are required as follows:]**
 1. **[On input side]**
 2. **[On output side]**
- F. Protection modules shall:
 1. Be **[3-element Gas Tube type] [Solid-State type] [hybrid Gas Tube/Solid State] [other]**
 2. Have nominal DC Breakdown voltage of **[230] [75] [240] V**
 3. Be self-resetting
 4. Provide effective protection against "sneak current" events
 5. Have fail-safe design to protect personnel and equipment from exposure to sustained high voltages and currents

2.07 POWER STRIP/SURGE SUPPRESSOR

- A. Manufacturers: CPI, Hubbell, Ortronics, Wiremold
- B. Power Strip/Surge Suppressor shall:
 1. Be rack mountable in 19" equipment racks
 2. Provide Transient suppression to 13,000 A
 - a. Protection shall be in 3 modes (hot-neutral, hot-ground and neutral-ground)
 3. Provide High Frequency Noise Suppression:
 - a. >20-dB @ 50-kHz
 - b. >40-dB @ 150-kHz
 - c. >80-dB @ 1-MHZ
 - d. >30-dB @ 6 to 1000 MHZ
 4. Provide minimum of 320 Joules of AC energy absorption
 5. Be equipped with minimum 12 ft power cord
 6. Be rated for 20A load at 120V
- C. Horizontally mounted suppressors shall be equipped with minimum **[6] [XXX]** receptacles.
 1. Minimum 2 receptacles shall be spaced to accommodate transformers.
- D. Vertically mounted suppressors shall be equipped with minimum **[10][XXX]** receptacles.
 1. Suppressor shall be **[maximum] [minimum] [48"] [XXX]** long.

PART 3 - EXECUTION

3.01 GENERAL

- A. Refer to project Drawings for communications equipment room layout and equipment placement.
- B. New communications equipment rooms must be free from dust, dirt, and other foreign materials before installation of any termination hardware or termination of copper or fiber optic cables.
 1. Door to room must be closed during termination if area outside room is not dust-free.
- C. Follow manufacturer's recommended installation and termination practices.
- D. Provide necessary assistance to allow Owner or Carrier personnel to establish service on new cable system.
 1. Includes general wiring overview, cable pair identification, and cross connect documentation (if applicable).

3.02 EQUIPMENT RACKS AND CABLE MANAGEMENT

- A. Provide equipment racks as shown on project Drawings.
- B. Assemble racks per manufacturer's recommendations. Remove paint at the point(s) of contact of assembly hardware or use internal-external tooth lock washers to pierce paint to maintain ground continuity.
- C. Bolt racks to floor.

- D. Secure racks to cable runway as described below.
- E. Provide Horizontal and Vertical Cable Management in equipment racks **[per project Drawings] [as follows]**.
 - 1. Provide horizontal cable management above and below each rack mounted patch panel.
 - 2. Provide vertical cable management between adjacent equipment racks and at rack row ends.
- F. Provide each rack with:
 - 1. Ground bar and #6 AWG Ground lug,
 - 2. Minimum of fifty (50) 12/24 mounting screws,
 - 3. Minimum of twelve (12) releasable (e.g. "hook & loop") cable support ties.
- G. Bond each rack mounted ground bar to telecommunications ground bus bar (TGB).
 - 1. Use #6 AWG or larger copper conductor (green jacket).

3.03 CABLE RUNWAY

- A. Provide cable runway and accessories necessary for complete system.
- B. Size and layout of cable runway shall be as shown on project Drawings.
- C. Install above equipment racks **[at 7'-6"] [at XXX] [as shown on drawings]**.
- D. Align with equipment racks **[as shown on drawings] [as follows:]**
 - 1. Where parallel to rack row, align **[one edge with front of racks and extend other edge beyond rear of racks] [center of runway with center of rack]**.
 - 2. Where at right-angle to rack, align center of runway with center of rack.
- E. Brace to racks with support brackets made by runway or rack manufacturer intended for this purpose.
- F. Use radius drops where cables drop from tray to rack and at elevation changes of 6" or more.
- G. Maximum allowable deviation of runway from level horizontal plane measured across length of cable runway shall be 1/2", with tray loaded to capacity.
- H. Where cable runway is supported from building structure:
 - 1. Provide 3/8" threaded rods for support of 12" wide or smaller runway.
 - 2. Provide 1/2" threaded rods for support of runway greater than 12" in width.
- I. Bond runway components together using manufacturer's standard accessories.
- J. Fasten cables to runway at intervals not to exceed 4 ft.

3.04 TERMINATION BLOCKS

- A. Provide blocks **[per project documents] [to accommodate an additional 20% growth at each location]**.
- B. Terminate Backbone Voice Cables **[and Horizontal Voice Cables]** on termination blocks.
 - 1. Strip lengths & termination of all cabling to be per manufacturers recommendations.
- C. Provide 110 blocks as follows:
 - 1. Horizontal Voice Cabling at horizontal cross-connect **[on free-standing equipment racks] [in wall-mounted patch field]**.
 - 2. Horizontal Data Cabling at horizontal cross-connect **[on free-standing equipment racks] [in wall-mounted patch field]**.
 - 3. Backbone Voice Cabling at horizontal cross-connect **[on free-standing equipment racks] [in wall-mounted patch field]**.
 - 4. Backbone Voice Cabling at main cross-connect **[on free-standing equipment racks] [in wall-mounted patch field]**.
 - 5. System Terminal Blocks at main cross-connect **[on free-standing equipment racks] [in wall-mounted patch field]**.
- D. Install Blocks:
 - 1. No higher than 72" AFF to top-most block
 - 2. Top to bottom, left to right beginning no closer than 12" from left wall

- E. Provide horizontal troughs between each termination block.
- F. Provide horizontal troughs at top of each block column.
- G. Provide vertical managers to right and left of each block column.
- H. Cabling entering and exiting fields shall be neatly laced, dressed and supported.
- I. Contractor **[shall] [shall not]** be responsible for jumper wiring between horizontal and backbone cabling.
 - 1. **[Cross-connect requirements]**
- J. Provide System Terminal Blocks as shown on drawings.
 - 1. **[Connect System Terminal Blocks to XXX]**
 - 2. Contractor shall not be responsible for jumper wiring between System Terminal Blocks and Backbone Voice Cable Blocks.
 - 3. Contractor shall not be responsible for connection of 50-pin telco connectors to Owner furnished telephone equipment.
- K. Provide Feed Blocks as shown on drawings.
 - 1. **[Connect Feed Blocks to Carrier Demarcation (DEMARC).]**

3.05 MODULAR PATCH PANELS

- A. Provide panels **[per project documents] [to accommodate an additional 20% growth at each location]**.
- B. Mount patch panels in 19" equipment racks.
- C. Position cables in sequence of:
 - 1. Telecommunications Outlet ID for horizontal cabling
 - 2. Pair number for backbone cabling
- D. Terminate cables using **[568A] [568B]** wiring standard.
- E. Provide horizontal management above and below each patch panel.
- F. Provide minimum of 4 screws to secure each patch panel onto rack.
- G. Bond F/UTP cable shield and drain wire to connecting hardware per manufacturer's instructions. Bond connecting hardware to the Telecommunications grounding system.

3.06 MID-SPAN POWER-OVER-ETHERNET HUB

- A. **[Article to be developed based on project need.]**

3.07 FIBER OPTIC PATCH PANELS

- A. Provide Fiber Optic Patch Panels and coupling assemblies **[as shown on drawings] [at horizontal and main cross-connect locations] [XXX]**.
 - 1. Provide minimum of 4 screws to secure each patch panel onto rack.
- B. Provide couplings in coupling assemblies and mount coupling assemblies and blank covers in patch panels.
- C. Position fibers consecutively - starting with lowest number - and mapped "position for position" between patch panels.
 - 1. There shall be no transpositions in cabling.
- D. Keyways on duplex couplings shall be oriented to establish "cross-over" in cabling system.
 - 1. Convention defined by TIA-568-C.0 (Annex B, Section B.3.2) shall be used.
 - 2. Reverse-pair positioning shall not be used.
- E. Provide blank covers for unused coupling assembly spaces in panels.
- F. Follow manufacturer's guidelines for connector type(s) provided.
 - 1. Clean connectors with specialized dry-cleaning product from Fluke or Cletop.
- G. Provide dust caps for couplings.
- H. **[Where factory-terminated cable assemblies ("pigtailed") are spliced to cable, prepare and splice cables and fibers per manufacturers' guidelines.]**

3.08 ENTRANCE PROTECTION

- A. Provide protector at each end on inter-building backbone copper pairs.
 - 1. Position protector as close as possible to building entrance.
- B. Install per manufacturers recommendations.
- C. Ground protector assemblies to Telecommunications Grounding Busbar via #6 AWG (minimum) conductors.
- D. Provide Protector Modules for **[50% of] [XXX% of]** pairs terminated.
- E. If special tool is required to open protector housing, provide 2 such tools to Owner at completion of work.

3.09 POWER STRIP/SURGE SUPPRESSOR

- A. Provide power strip/surge suppressor **[as shown on drawings] [in each rack]**.

3.010 FIELD TESTING

- A. General
 - 1. Refer to Section 27 0000 - General Communications Requirements and 27 1000 – Structured Cabling for guidelines regarding documentation requirements.
 - 2. Refer to referenced technical sections for detailed requirements to testing of each cable sub-system.

3.011 DOCUMENTATION

- A. General
 - 1. Refer to Sections 27 0000 - General Communications Requirements and 27 1000 – Structured Cabling for guidelines regarding documentation requirements.

END OF SECTION

**SECTION 27 1300
COMMUNICATIONS BACKBONE CABLING**

PART 1 - GENERAL

1.01 SCOPE

- A. This section details product and execution requirements for backbone cabling for Communications Systems.

1.02 DESCRIPTION

- A. Backbone Cabling links telecommunications rooms or floor distribution terminals, entrance facilities, and equipment rooms within or between buildings.
- B. Backbone cable types include:
1. **[Twisted-Pair Copper]**
 2. **[Fiber Optic]**
 3. **[Coaxial]**
- C. Refer to Project Drawings which detail Backbone Cable System topology and conductor/fiber counts.

1.03 RELATED WORK

- A. Related Division 27 Sections include:
1. Section 27 0000 - General Communications Requirements
 2. Section 27 0526 - Grounding and Bonding for Communications Systems
 3. Section 27 0528.29 - Hangers and Supports for Communications Systems
 4. Section 27 0528.33 - Raceway and Boxes for Communications Systems
 5. Section 27 0528.36 - Cable Tray for Communications Systems
 6. Section 27 0528.39 - Surface Raceways for Communications Systems
 7. Section 27 0553 - Communications Systems Identification
 8. Section 27 1000 - Structured Cabling
 9. Section 27 1100 - Communications Equipment Room Fittings
 10. Section 27 1500 - Communications Horizontal Cabling
 11. Section 27 1600 - Communication Connecting Cords, Devices and Adapters
 12. Section 27 5150 - Master Antenna Television Systems
 13. Section 27 5223 - Nurse Call System
- B. Related sections in other Divisions of Work:
1. Refer to individual technical sections identified above (if applicable).

1.04 REFERENCES & STANDARDS

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identify pertinent References and Standards.

1.05 DEFINITIONS

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Definitions used in this and related sections.

1.06 ABBREVIATIONS AND ACRONYMS

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Abbreviations and Acronyms used in this and related sections.

1.07 WORK BY OWNER

- A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.08 SUBMITTALS

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide general guidelines for product or installation information to be submitted by Contractor.
- B. In addition, submit:
 - 1. One 3 ft section of each cable type from cable reels sent to site for Engineer's final approval.
 - a. Section shall have manufacturer's cable markings visible.

1.09 QUALITY ASSURANCE

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identify general quality assurance requirements for the Project.

1.010 GUARANTEE

- A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.
- B. Refer to Section 27 1000 - Structured Cabling for particular Warranty requirements for Structured Cabling. Those requirements apply to cable and components covered in this section.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Cables and Termination hardware shall be technically compliant with and installed in accordance with referenced TIA documents.
- B. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of National Electrical Code and shall meet specifications of NEMA (low loss), UL 444, and ICEA (where applicable).

2.02 TWISTED PAIR CABLING

- A. General:
 - 1. Manufacturers: CommScope, Superior Essex, Mohawk
 - 2. Cable shall be standard exchange type telephone cable.
 - a. This is defined as paired multi-conductor, thermoplastic insulated, copper cable characterized by an average mutual capacitance of 83 (+4/-5) nano-Farads per mile at 1000 Hz.
 - 3. Cabling shall:
 - a. Be constructed of individually twisted pairs.
 - b. Be suitable for installation in environment defined.
 - c. Be packaged to minimize tangling and kinking of cable during installation.
 - 4. Identify conductors by insulation color.
 - 5. Color code shall follow industry standard of 10 distinctive colors to identify 25 pairs.
 - a. Marking of each mate of primary conductor in pair with color of that primary conductor is optional.
 - 6. When cables of larger than 25 pairs are required, cable core shall be assembled into 25-pair sub-units.
 - 7. Wrap super units with solid color thread that follows primary color scheme of white, red, black, yellow and violet.
 - 8. Cable jacket shall be marked at 2 ft intervals indicating manufacturers' identification, pair count, AWG and sequential footage.
- B. Backbone UTP Cable (Intra-building):
 - 1. Cable shall meet following minimum requirements:
 - a. Size: 24 AWG solid annealed copper pairs
 - b. Number of Pairs: as shown on Project Documents

- c. Impedance: 100 Ohms \pm 15%
 - d. Jacket Color: Black or Grey
 - e. Shield: Overall, continuous corrugated aluminum bonded to outer jacket
 - f. Cable Rating: NEC Article 800 Type CMR, UL listed
- C. **[Direct-buried] [Aerial]** Backbone UTP Cable (Outdoor):
- 1. Cable shall meet following minimum requirements:
 - a. Size: **[24 AWG] [22 AWG]** solid annealed copper pairs
 - b. Number of Pairs: as shown on Project Documents
 - c. Impedance: 100 Ohms \pm 15%
 - d. Jacket Color: Black
 - e. Shield: Overall, continuous corrugated aluminum bonded to outer jacket
 - 2. Cable shall be suitable for installation **[by lashing to an aerial messenger] [in underground duct] [and] [direct buried]**.
 - 3. Cable shall incorporate moisture-resistant filling and flooding compounds.

2.03 COAXIAL CABLING

- A. General
- 1. Manufacturers: Commscope, Times Fiber, Belden
 - 2. Coaxial cable shall be sweep tested 5 MHz to 2.25 GHz.
- B. RG-11 Type (Quad-shield)
- 1. Basic Construction:
 - a. Center conductor: 14 AWG copper-clad steel
 - b. Dielectric: Gas expanded (foamed) polyethylene
 - c. First shield: Aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric
 - d. Second shield: 34 AWG aluminum braid wire (60% coverage)
 - e. Third shield: Non-bonded foil shield
 - f. Fourth shield: 34 AWG aluminum braid wire (60% coverage)
 - g. Jacket: Flame retardant PVC
 - 1) Jacket shall contain carbon black to ensure ultraviolet light stability (UV).
 - 2. Specifications:
 - a. Impedance: 75 \pm 3 Ohms
 - b. Velocity of Propagation: 85% nominal
 - c. Attenuation (maximum) @ 68°F:
 - 1) 55 MHz: 0.96 dB/100 ft
 - 2) 750 MHz: 3.65 dB/100 ft
 - 3) 1 GHz: 4.35 dB/100 ft
 - 3. Cable Rating: Type CATVR
- C. .500 Type
- 1. Basic Construction
 - a. Center conductor: Copper-clad aluminum; 0.11" nominal diameter
 - b. Dielectric: Gas injected foam polyethylene
 - c. Outer shield: Continuous, solid aluminum
 - d. Jacket: Flame retardant polyethylene
 - 1) Jacket shall be free of pinholes, cracks and blisters.
 - 2) Jacket shall contain carbon black to ensure ultraviolet light stability (UV).
 - 2. Specifications:
 - a. Impedance: 75 \pm 2 Ohms
 - b. Capacitance: 15.3 \pm 1.0 pf/ft
 - c. Velocity of Propagation: 87% nominal

- d. Minimum Structural Return Loss: -30 dB (5-1000 MHz)
 - e. Attenuation (maximum) @ 68°F:
 - 1) 55 MHz: 0.54 dB/100 ft
 - 2) 750 MHz: 2.16 dB/100 ft
 - 3) 1 GHz: 2.52 dB/100 ft
 - 3. Cable Rating: Type CATVR
- D. .750 Type
- 1. Basic Construction
 - a. Center conductor: Copper-clad aluminum; 0.17" nominal diameter
 - b. Dielectric: Gas injected foam polyethylene
 - c. Outer shield: Continuous, solid aluminum
 - d. Jacket: Medium density polyethylene
 - 1) Jacket shall be free of pinholes, cracks and blisters.
 - 2) Jacket shall contain carbon black to ensure ultraviolet light stability (UV).
 - 2. Specifications:
 - a. Impedance: 75 ± 2 Ohms
 - b. Capacitance: 15.3 ± 1.0 pf/ft
 - c. Velocity of Propagation: 87% nominal
 - d. Minimum Structural Return Loss: -30 dB (5-1000 MHz)
 - e. Attenuation (maximum) @ 68°F:
 - 1) 55 MHz: 0.37 dB/100 ft
 - 2) 750 MHz: 1.48 dB/100 ft
 - 3) 1 GHz: 1.74 dB/100 ft
 - 3. Cable Rating: Type CATV

2.04 COAXIAL CABLE CONNECTOR

- A. Coaxial Connectors shall be threaded male F-type.
- B. Connectors shall:
 - 1. Be matched to cable type(s) used
 - 2. Be single piece connector
 - 3. **[Be Thomas & Betts Snap-n-Seal®][Incorporate crimp ring for use with a radial crimp tool]**
- C. Use female/female feed-through couplings at patch panels (if applicable).

2.05 FIBER OPTIC CABLE

- A. General
 - 1. Manufacturers (Cable): Corning, Siemon, Berk-Tek, CommScope
 - 2. Manufacturers (Optical Fiber): Corning, Alcatel
 - 3. Fibers utilized in installed cable shall be traceable to manufacturer.
- B. Optical Fiber - General
 - 1. Optical fibers shall:
 - a. Be sufficiently free of surface imperfections and occlusions to meet optical, mechanical, and environmental requirements of this specification.
 - b. Have been subjected to minimum tensile proof test by fiber manufacturer equivalent to 100 kpsi.
 - 2. Factory optical fiber splices are not allowed.
 - 3. Coatings shall be mechanically strippable without damaging optical fiber.
- C. 50 micron Multimode Optical Fibers:
 - 1. Fiber Type: Multimode; doped silica core surrounded by concentric glass cladding
 - 2. Strand Count: As shown on Drawings

3. Transmission Windows: 850 nm, 1300 nm
 4. Core Diameter: 50 micron \pm 3 micron
 5. Cladding Diameter: 125 micron \pm 2 micron
 6. Coating Diameter: 245 micron \pm 5 micron
 7. Maximum Attenuation:
 - a. 850 nm: 3.5 dB/km (at 23° \pm 5°C)
 - b. 1300 nm: 1.5 dB/km (at 23° \pm 5°C)
 - c. Attenuation performance is typical for generic 50 micron fiber grades. Better performance is available and can be considered for longer, inter-building links if required. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components", average change in attenuation over rated temperature range of cable shall not exceed 0.50 dB/km with 80% of measured fibers not exceeding 0.25 dB/km.
 8. Minimum LED Bandwidth:
 - a. 850 nm: **[500] [1500]** MHz*km
 - b. 1300 nm: 500 MHz*km
 9. Effective Modal Bandwidth:
 - a. 850 nm: **[500] [2000]** MHz*km
 10. Point Discontinuity: < 0.2 dB at specified wavelengths.
 11. Minimum supported Gigabit Ethernet distances shall be:
 - a. 850 nm window: **[300 m] [1000 m]**
 - b. 1300 nm window: **[500 m] [600 m]**
 12. Minimum supported Serial 10 Gigabit Ethernet distances shall be:
 - a. 850 nm window: **[80 m] [300 m]**
- D. 62.5 micron Multimode Optical Fibers:
1. Fiber Type: Multimode; doped silica core surrounded by concentric glass cladding
 2. Strand Count: As shown on drawings
 3. Transmission Windows: 850 nm, 1300 nm
 4. Core Diameter: 62.5 micron \pm 3 micron
 5. Cladding Diameter: 125 micron \pm 2 micron
 6. Coating Diameter: 245 micron \pm 5 micron
 7. Maximum Attenuation
 - a. 850 nm: 3.5 dB/km (at 23° \pm 5°C)
 - b. 1300 nm: 1.5 dB/km (at 23° \pm 5°C)
 - c. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components", average change in attenuation over rated temperature range of cable shall not exceed 0.50 dB/km with 80% of measured fibers not exceeding 0.25 dB/km.
 8. Minimum LED Bandwidth
 - a. 850 nm: 200 MHz*km
 - b. 1300 nm: 500 MHz*km
 9. Effective Modal Bandwidth (850 nm): **[220 MHz*km] [385 MHz*km]**
 10. Point Discontinuity: < 0.2 dB at specified wavelengths.
 11. Minimum supported Ethernet distances shall be:
 - a. Gigabit Ethernet at 850 nm window: **[300 m] [500 m]**
 - b. Gigabit Ethernet at 1300 nm window: **[550 m] [1000 m]**
 - c. Serial 10 Gigabit Ethernet at 850 nm window: 33 m

- E. Single-mode Optical Fibers:
 - 1. Single-mode Optical Fibers:
 - 2. Fiber Type: Single-mode
 - 3. Strand Count: as shown on Drawings
 - 4. Transmission Windows: 1310 nm, 1550 nm
 - 5. Core Diameter: 8.3 micron
 - 6. Cladding Diameter: 125 micron \pm 1 micron
 - 7. Coating Diameter: 245micron \pm 10 micron
 - 8. Maximum Attenuation:
 - a. 1310 nm: **[1.0][0.5]** dB/km (at 23° \pm 5°C)
 - b. 1550 nm: **[0.75][0.4]**-dB/km (at 23° \pm 5°C)
 - c. When tested in accordance with FOTP 3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical cable, and Other Passive Fiber Optic Components", average change in attenuation over rated temperature range of cable shall not exceed 0.05 dB/km at 1550 nm. Maximum attenuation change shall not exceed 0.15 dB/km at 1550 nm.
 - d. **[Water Peak Attenuation: 1383 \pm 3 nm (dB/km) \leq 0.4]**
 - 9. Point Discontinuity: < 0.1 dB at specified wavelengths
- F. Indoor Backbone Fiber Optic Cable
 - 1. Cable shall:
 - a. Be suitable for installation in free air, in building risers, in conduit, in cable tray and in innerduct.
 - b. Be dielectric materials (no conductive materials).
 - 2. Cable shall meet the following specifications:
 - a. Buffer Diameter: 900 micron (tight buffer)
 - b. Jacket Color
 - 1) **[All: BLACK]**
 - 2) Multimode: ORANGE
 - a) Exception: LASER-optimized 50/125 Multimode: AQUA
 - 3) Single-mode: YELLOW
 - 4) Hybrid (Multimode + Single-mode): BLACK
 - c. Cable Rating: **[OFNR] [OFNP]**
 - d. Strength Member: Aramid Yarn
 - e. Storage Temperature: -40°F to 158°F (no irreversible change in attenuation)
 - f. Operating Temperature: -34°F to 158°F (no irreversible change in attenuation)
 - g. Humidity Range: 0 to 100%
 - h. Maximum Tensile Strength:
 - 1) During Installation – 2700 N (no irreversible change in attenuation)
 - 2) Long Term – 1000 N
 - i. Bending Radius:
 - 1) During Installation - 20 times cable diameter
 - 2) No Load - 10 times cable diameter
- G. Indoor-Outdoor Backbone Fiber Optic Cable
 - 1. Cables shall:
 - a. Incorporate dry water-blocking materials
 - b. **[Incorporate an interlocking metal tape under outer jacket to provide crush resistance and rodent protection.]**
 - c. Be all dielectric (no conductive materials).
 - d. Be suitable for installation in underground conduit, in innerduct and indoor.

2. Cable shall meet the following specifications:
 - a. Buffer Type: Loose Tube
 - b. Jacket Color: Black or Gray
 - c. Cable Rating: OFNR **[OFCR if armored]**
 - d. Strength Member: Aramid Yarn
 - e. Anti-buckling element: fiberglass
 - f. Operating and Storage Temperature: -40°F to 158°F (no irreversible change in attenuation)
 - g. Humidity Range: 0 to 100%
 - h. Maximum Tensile Loading:
 - 1) During Installation - 2700 N (no irreversible change in attenuation)
 - 2) Long Term - 600 N
 - i. Bending Radius:
 - 1) During Installation - 20 times cable diameter
 - 2) No Load - 10 times cable diameter
- H. **[Direct Buried]** Outdoor Fiber Optic Cable:
 1. Cable shall:
 - a. Incorporate water-blocking materials.
 - b. **[Incorporate an interlocking metal tape under outer jacket to provide crush resistance and rodent protection.]**
 - c. Be all dielectric (no conductive materials).
 - 1) **[Exception - metal tape for cable armoring.]**
 - d. Be suitable for installation in underground duct **[and direct burial]**.
 - e. Meet the following specifications:
 - 1) Buffer Type: Loose Tube
 - 2) Jacket Color: Black
 - 3) Strength Member: Aramid Yarn
 - 4) Anti-buckling element: fiberglass
 - 5) Operating and Storage Temperature: -40°F to 158°F (no irreversible change in attenuation)
 - 6) Humidity Range: 0 to 100%
 - 7) Maximum Tensile Strength:
 - a) During Installation - 2700 N (no irreversible change in attenuation)
 - b) Long Term - 890 N
 - 8) Bending Radius:
 - a) During Installation - 20 times cable diameter
 - b) No Load - 10 times cable diameter

2.06 FIBER OPTIC CONNECTORS

- A. Manufacturers: Corning, Siemon, Panduit, Ortronics.
- B. Connectors shall:
 1. Be **[SC] [LC] [ST]**-type.
 2. Accept fibers having clad diameter of 125 micron.
 3. Accept fibers having buffered diameter of 900 micron.
 4. Sustain minimum of 200 mating cycles.
- C. Connector ferrule shall be **[ceramic or glass-in-ceramic] [or composite (polymer)]**.
- D. Connectors shall meet the following performance criteria:

<u>Test Procedure</u>	<u>Max. Attenuation Change</u>
1. Cable Retention (TIA-455-6).....	0.2 dB
2. Durability (TIA-455-21).....	0.2 dB

3. Impact (ANSI/TIA/EIA-455-2)..... 0.2 dB
4. Temperature Life (TIA/EIA-455-4)..... 0.2 dB
5. Humidity (TIA/EIA-455-5)..... 0.2 dB
- E. Optical fiber shall be:
 1. Secured within connector ferrule with adhesive, or
 2. Mechanically secured and mated to a factory-installed fiber stub that is fully bonded into the ferrule. Mechanical "splice" inside connector shall include an index matching gel.
- F. Attenuation per connector shall not exceed 0.5 dB.
- G. Reflectance (maximum) when mated with patch-cord made up of connectors of comparable design shall be as follows:
 1. Multimode: -20 dB
 2. Single-mode: **[-26 dB] [-40 dB] [-55 dB]**
- H. Color of **[SC] [LC]** Connector shall be as follows:
 1. Multimode: BEIGE
 - a. Strain-relief boot of connector terminating LASER-optimized 50 micron fiber shall be AQUA.
 2. Single-mode: BLUE
- I. Strain-relief boot of ST Connector shall indicate fiber type as follows:
 1. Multimode: BLACK
 2. Single-mode: YELLOW

PART 3 - EXECUTION

3.01 CABLE INSTALLATION AND TERMINATION

- A. General
 1. Provide cables as shown on Project Documents.
 2. Size cables as shown on Project Documents.
 3. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling for general cable installation requirements.
- B. Backbone UTP Voice Cable:
 1. Terminate cables on backbone voice cable blocks.
 - a. Maintain cables pair twists to within 1" of termination.
 - b. Remove cable jacket only to extent required to make terminations.
 2. Ground metallic cable sheath (if applicable) per Code.
 - a. Provide armored cable ground kit for armored cable terminations. Install as directed by kit manufacturer.
 - 1) Ground inter-building cable at one end
 - 2) Ground intra-building cabling at both ends
 3. Connect armored cable ground kit to wall-mounted TGB located in telecom room.
- C. Coax Cable and Equipment
 1. At Telecommunications Room(s):
 - a. **[Coil Cables for future termination (by others).**
 - 1) **Provide slack in each cable [10 ft][XXX][as required to reach tap/splitter location plus [XXX]].**
 - b. **Terminate cables in specified connector type.**
 - 1) **Prepare cables per manufacturers recommendations for connector type used.**
 - 2) **Provide proper center conductor length as specified by manufacturer.**
 - c. **Mate cables with taps and splitters as detailed on project drawings.**
 - d. **Mate cables with feed-through couplers mounted on panels.**

- 1) **Dress cables neatly at rear of panel and secure to cable management brackets.**
 - 2) **Size Panels to accommodate an additional 20% growth in number of cables terminated (each room).]**
2. Coordinate splitter location with Owner to ensure adequate cable lengths.
- D. Fiber Optic Cable
1. Route backbone fiber optic cable in innerduct.
 2. Ground metallic cable sheath (if applicable) per Code.
 - a. Provide armored fiber ground kit for armored cable terminations. Install as directed by kit manufacturer.
 - 1) Ground inter-building cable at one end
 - 2) Ground intra-building cabling at both ends
 - b. Connect armored fiber ground kit to rack mounted grounding reference.
 3. Terminate fiber strands on Fiber Optic Connectors mated to couplings mounted in Fiber Optic Patch Panels.
 - a. Terminate all fibers.
 4. Follow manufacturer's guidelines for connector type(s) provided.
 - a. Clean connectors with specialized dry-cleaning product from Fluke, ProLabs or Cletop.
 5. Fibers with coatings <900 micron shall be furcated (fanned-out) to minimum of 900 micron before termination.
 - a. Provide buffer tube fan-out kits for fibers terminated in patch panel couplings.
 6. Provide cable slack in each backbone fiber optic cable.
 - a. Slack shall be in addition to length of fiber required for termination requirements.
 - b. Store cable slack in enclosure designed for this purpose.
 - c. Slack required shall be as follows:
 - 1) Backbone Intra-Building: Minimum of 16 ft (each cable if applicable) coiled and secured at one end (preferably at Telecom Room).
 - 2) Backbone Inter-Building: Minimum of 50 ft (each cable if applicable) coiled and secured at one end (preferably at Equipment Room).
 - 3) Maintenance Holes/Manholes: Minimum of 1-1/2 times inside dimension of Maintenance Hole/Manhole.

3.02 FIELD TESTING

- A. General
1. Refer to Section 27 0000 - General Communications Requirements for general guidelines regarding requirements for scheduling and performance of compliance testing.
 - a. Contractor shall be responsible for testing each system end-to-end.
- B. Backbone UTP Cable Testing
1. Verify voice cable pairs for wire map (transposed/reversed/split pairs) and shorts through toning of each conductor.
 2. Verify cable shield or coupled bonding conductor for end-to-end continuity.
- C. Backbone Coaxial Cable Testing
1. Cables shall be tested using Wire Test Instrument to:
 - a. Locate breaks/faults/incorrect terminations
 - b. Verify length
 - c. Verify impedance
 - d. Return Loss (5 MHz to 1 GHz)
 2. Terminate cable - as required by individual tests - with its characteristic impedance.
- D. Backbone Fiber Optic Cable Testing
1. Pre-Installation Testing

- a. Pre-installation testing shall be done at contractor option.
 - b. Submit cable manufacturer's test report for each reel of cable provided.
 - 1) Verify fiber attenuation, bandwidth and length values as specified on cable data sheets supplied with cable reels.
 - c. Visually inspect reels and packaging for damage.
2. Post-Installation Testing
- a. Clean fiber optic connectors before beginning testing.
 - 1) Using fiber tester capable of fiber end face inspection is strongly encouraged to help minimize requirement for retesting due to dirty connectors.
 - b. Testing shall include:
 - 1) Optical Attenuation
 - 2) Optical Time Domain Reflectometry (OTDR)
 - 3) **[Optical Return Loss]**
 - c. Optical Attenuation
 - 1) Light Source: **[LED][VCSEL for 850 nm tests; FP LASER for 1300 nm tests]**
 - 2) Measure Optical Attenuation on terminated fibers.
 - a) Include optical connectors and couplings installed at fiber endpoints.
 - 3) Test multimode fibers using TIA 526-14-C, Annex A.
 - 4) Test single-mode fibers using TIA 526-7-A, Annex E (Method A).
 - 5) Test fibers in both transmission directions.
 - 6) Test multimode fibers at 850 ± 30 nm and 1300 ± 20 nm wavelengths.
 - 7) Test single-mode fibers at 1310 ± 10 nm **[and 1550 ± 10 nm]** wavelength[s].
 - 8) Fiber lengths less than or equal to 300 ft shall test to ≤ 2.0 dB loss.
 - 9) Fiber lengths greater than 300 ft shall test to loss value less than link loss budget for installed connectors and fibers.
 - d. Optical Time Domain Reflectometry (OTDR)
 - 1) OTDR testing shall not be used as the sole method for establishing optical attenuation link loss.
 - 2) Verify fiber integrity using an Optical Time Domain Reflectometer (OTDR).
 - a) Includes terminated and (if applicable) un-terminated fibers.
 - 3) OTDR(s) shall incorporate high-resolution optics and short pulse-width options optimized for viewing of short cable sections.
 - a) Pulse-width shall be 10-ns or less for cable lengths greater than 100 meters.
 - b) Pulse-width shall be 5-ns or less for cable lengths less than 100 meters.
 - 4) OTDR traces shall be performed in one direction using access jumpers at transmit and receive ends.
 - a) Remote end of tail cord has no requirement for reference grade termination
 - 5) OTDR traces shall be performed in two directions using access jumpers at transmit and receive ends
 - a) Remote end of tail cord shall meet same reference grade requirements as launch end cord.
 - b) Perform bi-directional OTDR measurements according to requirements of TIA-526-7-A, clauses H.6 and H.7.
 - c) Minimum length of access jumper at launch end shall be minimum 330 ft long for multimode or 990 ft long for single-mode, unless recommended otherwise by test equipment manufacturer.
 - 6) Test multimode fibers at 850 ± 30 nm wavelength.
 - 7) Test single-mode fibers at 1310 ± 10 nm wavelengths.
 - 8) Examine traces for continuity and anomalies to confirm fiber link integrity.

- a) Point discontinuities in excess of 0.2 dB for multimode fibers or 0.1 dB for single-mode fibers shall be cause for rejection of cable.
 - b) Any reflection in trace - except at patch panels - shall be cause for rejection of cable.
 - c) Submitted test results shall show only fiber under test and shall have trace boundaries set to show fiber under test and not launch cords or other extraneous data.
 - d) Set event markers to accurately reflect overall attenuation of installed fiber optic cable and connectors.
- 9) OTDR tested links showing excessive backscatter immediately following connector shall have connector cleaned and/or re-polished and then retested.
- e. **[Optical Return Loss]**
- 1) **[Testing shall include Optical Return Loss (ORL) measurement for each installed single mode fiber optic connector. Follow OTDR manufacturer's requirements for required tester settings, including scattering coefficient.]**
 - 2) **[Perform ORL with a Back Reflection Meter or an OTDR.**
 - a) **[OTDR shall be capable of measuring fiber connector reflectance and produce accurate (± 2 dB) reflectance measurements]**
 - 3) **[Test result cursors shall be placed at appropriate locations before tests are submitted for review. OTDR testers including automatic cursor positioning functions shall use said functions to position cursors accurately for measurement.]**

3.03 DOCUMENTATION

- A. General
 1. Refer to Section 27 0000 - General Communications Requirements for general guidelines regarding documentation requirements.
- B. Backbone Copper Cable
 1. Document pair count assignments by cable.
 2. **[Document cross-connects between backbone, and horizontal or tie cabling.**
 - a. **Documentation shall be in the form of a spreadsheet which relates backbone pair count with horizontal cable or tie cable information. Base horizontal cable information on outlet designation and pair count.]**
- C. Backbone Fiber Optic Cable
 1. Files containing Attenuation and OTDR traces of individual optical fiber "signatures" shall be so named as to identify each individual fiber by location in cable system and fiber number or color.
 2. OTDR test results shall be consistent in format and presentation, including:
 - a. Scale
 - 1) Scale or window of test result view shall show only enough trace to view fiber under test plus launch cords at both ends.
 - 2) View shall not show backscatter beyond end of fiber.
 - b. Pulse width
 - c. Units (English or Metric)
 - d. Cursor placement
 - e. Labeling

END OF SECTION

**SECTION 27 1500
COMMUNICATIONS HORIZONTAL CABLING**

PART 1 - GENERAL

1.01 SCOPE

- A. This section details product and execution requirements for Horizontal (Station) Cabling subsystem for Communications Systems.

1.02 DESCRIPTION

- A. Horizontal cabling subsystem is portion of communication link that connects horizontal or intermediate cross-connect (typically at Telecom Room) and Telecommunications Outlet.
- B. Horizontal Cable types include:
1. **[4-pair Copper Unshielded Twisted Pair (UTP)]**
 2. **[4-pair Copper Foiled Unshielded Twisted Pair (F/UTP)]**
 3. **[Coaxial]**
 4. **[Fiber Optic]**
 5. **[Other]**

1.03 RELATED WORK

- A. Related Division 27 Sections include:
1. Section 27 0000 - General Communications Requirements
 2. Section 27 0526 - Grounding and Bonding for Communications Systems
 3. Section 27 0528.29 - Hangers and Supports for Communications Systems
 4. Section 27 0528.33 - Raceway and Boxes for Communications Systems
 5. Section 27 0528.36 - Cable Tray for Communications Systems
 6. Section 27 0528.39 - Surface Raceways for Communications Systems
 7. Section 27 0553 - Communications Systems Identification
 8. Section 27 1000 - Structured Cabling
 9. Section 27 1100 - Communications Equipment Room Fittings
 10. Section 27 1300 - Communications Backbone Cabling
 11. Section 27 1600 - Communication Connecting Cords, Devices and Adapters.
 12. Section 27 5150 - Master Antenna Television Systems
 13. Section 27 5223 - Nurse Call System
- B. Related sections in other Divisions of Work:
1. Refer to individual technical sections identified above (if applicable).

1.04 REFERENCES AND STANDARDS

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identifies pertinent References and Standards.
- B. Other applicable references and standards include:
1. **[XXX]**

1.05 DEFINITIONS

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Definitions used in this and related Sections.
- B. In this section, "Telecommunications Outlet" is considered to consist of Frame/Faceplate into which Modular Jacks or other couplings snap, Modular Jacks, blanks fitted to unused jack positions, and labeling/identification components.

1.06 ABBREVIATIONS AND ACRONYMS

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Abbreviations and Acronyms used in this and related Sections.

1.07 WORK BY OWNER

- A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.08 SUBMITTALS

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide general guidelines for product or installation information to be submitted by Contractor.
- B. In addition, submit:
 - 1. Samples of each Telecommunications Outlet Faceplate type to confirm color and material.
 - 2. One 3 ft section of each cable type from cable reels sent to site for Engineer's final approval.
 - a. Section shall have manufacturer's cable markings visible.
 - 3. Nominal Velocity of Propagation (NVP) for 4-pair Horizontal Copper Cable.

1.09 QUALITY ASSURANCE

- A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identify general quality assurance requirements for the Project.

1.010 GUARANTEE

- A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.
- B. Refer to Section 27 1000 - Structured Cabling for particular Warranty requirements for Structured Cabling. Those requirements apply to all cable and components covered in this section.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Cables and Termination hardware shall be technically compliant with and installed in accordance with referenced TIA documents.
- B. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of National Electrical Code and shall meet specifications of NEMA (low loss), UL 444, and ICEA (where applicable).
- C. Horizontal (Station) Cable and Termination Components (Jack, Patch Panel) are specified to function as System.
 - 1. Where required for warranty purposes, manufacturers of cabling and termination components used (if more than one) shall recognize each other in their Certification Programs.
- D. 4-Pair Horizontal Copper Cables and Modular Jacks are application **[dependent as detailed below][independent (e.g. no distinction between "voice" and "data")]**.

2.02 4-PAIR HORIZONTAL COPPER CABLE

- A. Manufacturers: Refer to System Requirements list in 27 1000
 - 1. **[Cable Trade Names if Required]**
- B. Cables shall be suitable for installation in environment defined
- C. Cabling shall be packaged to minimize tangling and kinking of cable during installation.
- D. Configuration:
 - 1. Number of Pairs: 4 twisted pair
 - a. Pair twists of any pair shall not be same as any other pair.
 - b. Pair twist lengths shall be selected by manufacturer to ensure compliance with crosstalk requirements of TIA 568.
 - 2. Conductors: insulated solid annealed copper pairs

- a. Category 3 - 5e: 24 AWG
 - b. Category 6 & 6A: 23 AWG
 - c. Pairs of 4-pair cables shall be identified by banded color code in which conductor insulation is marked with dominant color and banded with contrasting color.
 - 1) By pair number, pair colors or dominant band are:
 - a) Pair 1: Tip - White/Blue; Ring - Blue (or Blue/White)
 - b) Pair 2: Tip - White/Orange; Ring - Orange (or Orange/White)
 - c) Pair 3: Tip - White/Green; Ring - Green (or Green/White)
 - d) Pair 4: Tip - White/Brown; Ring - Brown (or Brown/White)
 3. Shield: **[None] [XXX]**
 - a. Drain Wire: None
 4. Cable Rating: NEC Article 800 Type **[CM] [CMR] [CMP]**, UL listed
 5. Maximum outside diameter:
 - a. Category 5e: 0.22 inches
 - b. Category 6: 0.25 inches
 - c. Category 6A: 0.28 inches
 6. **[Cabling rated Category 6A shall include a non-continuous shield component under the outer cable jacket.]**
- E. Horizontal Data Cable:
1. Shall meet or exceed **[TIA Category 5e] [TIA Category 6] [TIA Category 6A]** performance requirements.
 2. **[Shall] [Shall not]** incorporate an overall shield.
 3. Jacket Color: **[Blue] [XXX]**
- F. Horizontal Voice Cable:
1. Shall meet or exceed **[TIA Category 3] [TIA Category 5e] [TIA Category 6]** performance requirements.
 2. **[Shall] [Shall not]** incorporate an overall shield.
 3. Jacket Color **[White] [Gray] [XXX]**
- G. Horizontal Cable for Building Automation:
1. Shall meet or exceed performance requirements of TIA **[Category 3] [Category 5e] [Category 6]**.
 2. **[Shall] [Shall not]** incorporate an overall shield.
 3. Jacket Color: **[Pink] [XXX]**

2.03 HORIZONTAL COAXIAL CABLE

- A. Manufacturers: CommScope, Belden.
- B. Cables shall be suitable for installation in environment defined and shall meet **[General Purpose - CATV] [Riser - CATVR] [Plenum - CATVP]** rating (or permitted substitute as defined by NEC).
- C. Station Coaxial Cable shall be RG-6 type, **[Dual-shield] [Quad-shield]**
- D. Coaxial cable shall be sweep tested 5 MHz to 2.25 GHz.
- E. RG-6 Type (Dual-shield)
 1. Center conductor: 18 AWG copper-clad steel.
 2. Dielectric: **[Gas expanded (foamed) polyethylene] [Foam FEP or equivalent as required for cable rating]**.
 3. First shield: Aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
 4. Second shield: 34 AWG aluminum braid wire (60% coverage).
 5. Impedance: 75 ± 3 ohms
 6. Velocity of Propagation: 83% nominal

7. Maximum Attenuation @ 68°F:
 - a. 55 MHz: 1.60 dB/100 ft
 - b. 750 MHz: **[5.65] [6.6]** dB/100 ft
 - c. 1 GHz **[6.1] [8.2]** dB/100 ft
- F. RG-6 Type (Quad-shield)
 1. Center Conductor: 18 AWG copper-clad steel.
 2. Dielectric: **[Gas expanded (foamed) polyethylene] [foam FEP or equivalent as required for cable rating]**.
 3. First shield: Aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
 4. Second shield: 34 AWG aluminum braid wire (60% coverage).
 5. Third shield: Non-bonded foil shield.
 6. Fourth shield: 34 AWG aluminum braid wire (60% coverage).
 7. Impedance: 75 ± 3 ohms
 8. Velocity of Propagation: 83% nominal
 9. Maximum Attenuation @ 68°F:
 - a. 55 MHz: 1.60 dB/100 ft
 - b. 750 MHz: **[5.65] [6.6]** dB/100 ft
 - c. 1 GHz: **[6.1] [8.2]** dB/100 ft

2.04 HORIZONTAL FIBER OPTIC CABLE

- A. Fiber Optic Cable
 1. Cable shall:
 - a. Incorporate 2 tight-buffered fiber strands in single jacket.
 - b. Incorporate duplex design with 1 tight buffered fiber strand in each jacket.
 - c. Allow direct terminations on specified fiber optic connectors.

2.05 TELECOMMUNICATIONS OUTLET

- A. Manufacturers: Refer to System Requirements list in 27 1000
- B. Connectors (modular jacks, fiber optic couplings and coaxial connectors (as applicable)) shall snap onto faceplate.
 1. In surface-mount designs (if applicable) Jacks and connectors may mount to frame onto which coverplate is mounted.
- C. Work Area Faceplate
 1. Wall-mounted faceplates intended to be used in general work areas shall:
 - a. Be configured to mount on standard, **[single] [dual]** gang opening when wall mounted.
 - b. Accommodate minimum of **[4] [6] [XXX]** modular jacks and connectors.
 - c. Be constructed of high impact plastic (except where otherwise noted).
 - d. Incorporate recessed designation strips at top and bottom of frame for identifying labels.
 - 1) Triple row faceplates with no provisions for labeling of middle outlet row are not acceptable.
 - 2) Designation strips shall be fitted with clear plastic covers.
 - 3) Designation strips and covers shall be positioned over faceplate mounting screws.
 2. Faceplate Color: **[White] [Office White] [Electric Ivory] [to match electrical device faceplates]**.
- D. Wall-mount Telephone Faceplate
 1. Faceplates intended to be used in locations where wall mounted telephone set is required shall:
 - a. Be stainless steel construction.

- b. Accommodate 1 modular jack meeting performance requirements for "Voice" jack as defined above.
 - 1) Modular jack shall be positioned to mate with wall-mounted telephone.
 - c. Mount on standard single gang opening.
 - d. Include mating lugs for mounting wall-mounted telephone.
- E. Faceplate - Wireless Access Point Location
- 1. Faceplates supporting Wireless Access Point (AP) shall:
 - a. Accept **[2] [XXX]** modular jacks or connectors.
 - b. Be **[Surface-mounted] [flush-mounted] [mounted in an enclosure designed for AP]**.
 - c. Be made of High Impact thermoplastic.
 - d. **[Incorporate recessed designation strips at top and bottom of frame for identifying labels.]**
 - 2. Faceplate Color: **[White] [Office White] [Electric Ivory] [to match electrical device faceplates]**.
- F. Faceplate - Surface Raceway
- 1. Faceplates intended to be used on surface raceway shall:
 - a. Accept **[3] [2] [4]** modular jacks or connectors.
 - b. Snap into raceway opening and be retained by integral latching tabs.
 - 1) Match standard opening of raceway type(s) to be installed.
 - c. Have an optional extender bracket available to increase mounting depth.
 - d. Be made of High Impact thermoplastic.
 - e. **[Incorporate recessed designation strips for identifying labels.] [Have optional port designation stencils.]**
 - 1) Raceway faceplate color shall be **[Black] [XXX] [match color of raceway]**.
- G. Faceplate - Modular Furniture
- 1. Faceplates intended to be used on modular furniture shall:
 - a. Accept **[3] [2] [4]** modular jacks or connectors.
 - b. Snap into modular furniture opening and be retained by integral latching tabs.
 - c. Match standard opening of furniture type(s) to be installed. Furniture types include:
 - 1) **[Enter Furniture Type(s)]**
 - d. Have an optional extender bracket available to increase mounting depth as required to maintain cable bend radius within manufacturers' recommendations.
 - e. Be made of High Impact thermoplastic.
 - f. **[Incorporate recessed designation strips for identifying labels.] [Have optional port designation stencils.]**
 - 1) Modular furniture faceplate color shall be **[Black] [XXX] [match color of furniture panel]**.
- H. Faceplate - Industrial
- 1. Faceplates used in areas requiring a rugged, dust & water-tight assembly as identified on Project drawings shall:
 - a. Accept **[1] [2]** modular jacks or connectors.
 - b. Be configured to mount on standard, single gang opening when wall mounted.
 - c. Be designed for industrial application.
 - d. Meet IP67 sealing requirements.
 - e. **[Incorporate recessed designation strips at top and bottom of frame for identifying labels.]**
 - 2. Housing holding modular jack(s) shall be designed to mate with patch cord plug having bayonet-type twist mount.

3. Faceplate material shall be **[durable, chemical-resistant, industrial-grade thermoplastic] [Stainless Steel] [Powder-coated steel]**.
4. Telecommunications Outlet shall be equipped with dust cap to protect unused outlets or to seal an outlet during cleaning periods when outlet and plug may be disconnected.
 - a. Dust cap shall be constructed of industrial grade thermoplastic.
 - b. Dust cap shall include tether which prevents them from being misplaced when not in use.

2.06 MODULAR JACK

- A. Manufacturers: Refer to "Telecommunications Outlet" above.
- B. Modular Jacks shall be:
 1. 8-position, 8-conductor (8P8C)
 2. Non-keyed
- C. Jacks shall have an attached color-coded wiring instruction label as an aid to installer.
- D. Interface between jack and station cable shall be insulation displacement type contact.
- E. Termination components shall maintain cable's pair twists as closely as possible to point of mechanical termination.
- F. Jack contacts shall have minimum of 50 micro-inches of gold plating.
- G. Jacks shall be supplied with installed dust covers to protect jack opening and internal elements during installation until jack is in use.
 1. No damage to Jack pinning shall result from insertion or removal of covers.
 2. **[Dust cover shall be designed to remain with jack assembly when jack is in use.]**
- H. Data Jack shall:
 1. Meet or exceed performance requirements of **[TIA Category 5e] [TIA Category 6] [TIA Category 6A]**.
 2. Be color **[Blue] [Orange] [XXX]**
 - a. Alternately, color-coded Bezel or Icon may be used to identify Jack type.
- I. Voice Jack shall
 1. Meet or exceed performance requirements of **[TIA Category 3] [TIA Category 5e] [TIA Category 6] [TIA Category 6A]**.
 2. Be color **[Blue] [Orange] [White] [XXX]**
 - a. Alternately, Color-coded Bezel or Icon may be used to identify Jack type.
- J. MPTL connector shall
 1. Meet or exceed performance requirements of **[TIA Category 3] [TIA Category 5e] [TIA Category 6] [TIA Category 6A]**.
 2. Comply with Annex F of TIA-568.2-D.

2.07 COAXIAL CONNECTOR

- A. Coaxial Connectors shall be threaded male F-type.
- B. Male F-connectors shall:
 1. Be matched to cable type(s) used.
 2. Be single piece connector.
 3. **[Be Thomas & Betts Snap-n-Seal®][Incorporate crimp ring for use with a radial crimp tool]**.
- C. Use female/female feed-through couplings for coaxial outlets and patch panels (if applicable).

2.08 FIBER OPTIC CONNECTOR

- A. Manufacturers: Corning, Siemon, Panduit or Ortronics.
- B. Connectors shall:
 1. Be **[SC] [LC] [ST] [XXX]**-type.
 2. Accept fibers having clad diameter of 125 micron.

3. Accept fibers having buffered diameter of 900 micron.
4. Sustain minimum of 200 mating cycles.
- C. Multimode Connectors shall:
 1. **[Secure optical fiber in ferrule and connector body using epoxy][Be no-epoxy, no-polish design and include index matching gel in ferrule.]**
- D. Single-mode Connectors shall:
 1. **[Secure optical fiber in ferrule and connector body using epoxy.][Be no-epoxy, no-polish design and include index matching gel in ferrule.]**
- E. Connector ferrule shall be **[ceramic or glass-in-ceramic][or composite (polymer)]**.
- F. Connectors shall meet the following performance criteria:

<u>Test Procedure</u>	<u>Max. Attenuation Change</u>
1. Cable Retention (FOTP-6)	0.2 dB
2. Durability (FOTP-21)	0.2 dB
3. Impact (FOTP-2)	0.2 dB
4. Thermal Shock (FOTP-3).....	0.2 dB
5. Humidity (FOTP-5)	0.2 dB
- G. Attenuation per connector shall not exceed **[0.5] [XXX] dB**.

PART 3 - EXECUTION

3.01 GENERAL

- A. Refer to project Drawings for outlet **[and Consolidation Point]** locations.
- B. Provide Modular Jacks, Coaxial Connectors (if applicable) and Fiber Optic couplings (if applicable) in faceplates as shown on Project Documents.
 1. Provide **[1] [XXX]** faceplate per Telecommunications Outlet symbol shown on Project Documents.
 2. Provide **[1] [XXX]** modular furniture mounted faceplate per modular furniture symbol shown on Project Documents.
- C. **[Provide (1) Consolidation Point per CP symbol shown on Project drawings.]**
- D. Maximum 4-pair Category-rated horizontal cable length shall not exceed 295 feet (90 m) measured from horizontal cross-connect (typically at TR) to Telecommunications Outlet.
 1. Includes slack required for installation and termination.
 2. Contractor is responsible for installing station cable to avoid unnecessarily long runs.
 3. Any area that cannot be reached within above constraints shall be identified and reported to Engineer prior to installation.
- E. Follow manufacturers recommended termination practices.

3.02 CABLE INSTALLATION AND TERMINATION

- A. General
 1. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling for general cable installation requirements.
 2. Provide "Service Loop" for every Horizontal Cable in ceiling above outlet.
 - a. Loop length shall be 3.3 ft
 - b. Total length of 4-pair Category-rated horizontal cable including loop shall not exceed 295 feet (90 m).
 - c. Place loop in ceiling at last support (e.g. J-Hook) before cables enter fishable wall, conduit, surface raceway or box.
 - d. Coil loop in figure 8 configuration.
 - e. Loop radius (minimum) shall be 4X minimum bend radius for cable.
 3. During installation, minimum bend radius shall be eight times outside diameter of UTP cables and 20 times outside diameter of fiber cables.

4. **[Limit size of cable bundles along cable pathways and in communications equipment rooms to maximum of 12-24 cables.]**
 5. **[Route 10G UTP cable and other UTP cable categories independently. Do not bundle or share conduits. In cable tray segregate cable types using a physical barrier.]**
- B. Horizontal Copper Twisted-Pair Cabling
1. Provide horizontal copper twisted pair cable between horizontal cross connect (typically at Telecommunications Room) and Telecommunications Outlet.
 2. At Telecommunications Outlet, terminate each 4-pair Horizontal Cable on 8P8C Modular Jack.
 - a. Terminating one cable on more than one jack is not allowed.
 3. At horizontal cross-connect, terminate:
 - a. Each 4-pair cable on **[8P8C Modular Jack in Patch Panel] [Termination Block]**.
 - b. Each 4-pair cable designated as for "Data" on **[8P8C Modular Jack in Patch Panel] [Termination Block]**.
 - c. Each 4-pair cable designated as for "Voice" on **[8P8C Modular Jack in Patch Panel] [Termination Block]**.
 4. Terminate cables using **[568A] [568B]** wiring standard.
 5. Cable jacket shall be continuous to within 1/2" of termination.
 6. Preserve pair twists to point of termination.
 7. Refer to Section 27 1100 - Communications Equipment Room Fittings for termination instructions for Modular Patch Panel and Termination Block.
- C. Horizontal Coaxial Cable
1. Provide horizontal coaxial cable between Telecommunications Room(s) and coaxial workstation outlets.
 2. At Telecommunications Room(s):
 - a. **[Coil Cables for future termination (by others).]**
 - 1) **[Provide slack in each cable [10 ft] [XXX] [as required to reach tap/splitter location plus [XXX]].]**
 - b. **[Terminate cables in specified connector type.]**
 - 1) **[Prepare cables per manufacturers recommendations for connector type used.]**
 - 2) **[Ensure proper center conductor length as specified by manufacturer.]**
 - c. **[Mate cables with taps and splitters as detailed on project drawings.]**
 - d. **[Mate cables with feed-through couplers mounted on panels.]**
 - 1) **[Dress cables neatly at rear of panel and secure to cable management brackets.]**
 - 2) **[Size Panels to accommodate an additional 20% growth in number of cables terminated (each room).]**
 3. Coordinate splitter location with Owner to ensure adequate cable lengths.
 4. At Coax Outlet, mate Male with Female port on Tap or Female/Female Feed-thru Coupling, whichever is applicable for the outlet type specified.
- D. Horizontal Fiber Optic Cable
1. Terminate cables on specified fiber optic connectors at Telecommunications Outlet and at horizontal cross-connect.
 - a. Cable termination shall carry fiber buffer into connector strain relief mechanism.
 2. Mount connectors in fiber patch panels at horizontal cross-connect as shown on drawings.
 3. Refer to Section 27 1100 - Communications Equipment Room Fittings for termination instructions.

3.03 TELECOMMUNICATIONS OUTLET

- A. Faceplates shall be configured to provide connectivity as required by location. Refer to **[schedules] [details] [drawings]**.
- B. Mount modular jacks and connectors into faceplates and secure faceplates to outlet box, raceway or modular furniture.
 - 1. Use faceplate extender if required to provide adequate clearance between jack and furniture or raceway panel to maintain minimum cable bend radius.
 - 2. Provide blank(s) in unused jack/connector positions. Match color of blank to faceplate color.
- C. Position Telecommunications Outlet for wall-mounted telephone in area clear of other utilities and wall mounted hardware.
 - 1. Coordinate with other trades to maintain 8" clear space (minimum) on all sides from faceplate centerline.
- D. MPTL connectors shall be installed following connector manufacturer requirements.
 - 1. Contractor shall ensure installed MPTL will fit in available space at outlet-end of cable while maintaining cable bend radius requirements.

3.04 FIELD TESTING

- A. Refer to Sections 27 0000 - General Communications Requirements and 27 1000 – Structured Cabling for guidelines regarding testing requirements common to all Division 27 Structured Cabling sections.
 - 1. In addition, refer to sub-sections below for cable type under test.
- B. 4-Pair Horizontal Copper Cable
 - 1. Test from:
 - a. Horizontal Cross-connect (HC) to Jack at Telecommunications Outlet (TO).
 - b. **[Horizontal Cross-connect to Jack at Consolidation Point (CP)**
 - c. **HC – CP – TO. Test is in addition to HC-CP test described above.]**
 - 2. Testing shall be per TIA-568 Permanent Link test configurations.
 - 3. Maximum length of station cable shall not exceed 300 ft.
 - 4. Cables shall be free of shorts within pairs, and be verified for Continuity, Pair Validity and Polarity, and Wire Map (Conductor Position on Modular Jack).
 - a. Identify and correct defective, split or mis-positioned pairs.
 - 5. In addition to above, Performance Testing shall be performed on all cables. Testing of Transmission Performance shall include the following:
 - a. Length
 - b. Insertion Loss / Attenuation
 - c. Pair-to-pair NEXT
 - d. PSNEXT
 - e. Pair-to-pair ELFEXT (Equal Level Far End Cross-talk)
 - f. PSELFEXT
 - g. Return Loss
 - h. Propagation Delay
 - i. Delay Skew
 - j. **[Alien Crosstalk (AXTalk) – 10G Cable Systems only**
 - 1) **AXTalk measurement method shall be as required by the manufacturer(s) of cabling/connecting components installed to certify the system for warranty.]**
 - k. **[DC Loop Resistance and DC Resistance Unbalance (Pair and Pair-to-Pair values)]**
 - 1) **[Configure test equipment to include DC Loop Resistance and DC Resistance Unbalance as criteria for setting PASS/FAIL for each item under test.]**

- a) **[For example, when using Fluke test equipment, select “+PoE” test limit, and when using IDEAL test equipment select “MAX” test limit when setting test parameters.]**
 6. Test cables to maximum frequency defined by standards covering specified performance category.
 7. Perform Transmission Performance Testing using test instrument designed for testing to specified frequencies.
 - a. Test records shall verify "PASS" on each cable and display specified parameters - comparing test values with standards based "templates" integral to unit.
 8. MPTL cables shall be tested in accordance with TIA-568.2-D, Annex F, and test procedure shall follow recommended guidelines of test equipment manufacturer.
 - a. Select MPTL test limit on test equipment when testing MPTL terminated cables.
 9. **[Perform voltage measurement at the TO between the F/UTP cable shield and the ground wire of the electrical outlet used to supply power to the work station.]**
 - a. **Voltage shall not exceed 1.0 V rms.**
 - 1) **Where above value is exceeded, identify and correct problem. Then repeat the test.**
 - a) **Where condition causing problem is identified as being outside Division 27 work, identify condition to Division 26 contractor for resolution.**
 10. **Connect mid-span PoE Power Supplies and repeat test of horizontal link on all ports.]**
- C. Horizontal Coax Cable
1. All cables shall be tested using Wire Test Instrument to:
 - a. Verify length
 - b. Verify Resistance
 - c. Verify impedance
 - d. Locate breaks/faults/incorrect terminations and large impedance changes
 2. Terminate cable - as required by individual tests - with its characteristic impedance.
- D. Horizontal Fiber Optic Cable
1. Testing shall include
 - a. Optical Attenuation
 - 1) Light Source: **[LED][VCSEL for 850-nm tests; FP LASER for 1300-nm tests]**
 - 2) Measure Optical Attenuation on terminated fibers.
 - a) Include optical connectors and couplings installed at fiber endpoints.
 - 3) Test multimode fibers using EIA/TIA 526-14A, Method B.
 - 4) Test single-mode fibers using EIA/TIA 526-7-1998. Method A.1.
 - 5) Test all fibers in both transmission directions.
 - 6) Test multimode fibers at 850 ± 30 nm and 1300 ± 20 nm wavelengths.
 - 7) Test single-mode fibers at 1300 ± 20 nm wavelength[s].
 - 8) Fiber lengths less than or equal to 300 ft shall test to ≤ 2.0 dB loss.
 - 9) Fiber lengths greater than 300 ft shall test to loss value less than link loss budget for installed connectors and fibers.
 2. Perform inspection with OTDR if end-to-end readings are higher than expected to determine source of attenuation. Correct problem(s) and repeat Attenuation measurement until results within specified limits are obtained.

3.05 DOCUMENTATION

- A. Refer to Sections 27 0000 - General Communications Requirements and 27 1000 – Structured Cabling for documentation guidelines.

- B. Information added by Contractor to Record Drawings relating to Horizontal Cabling shall include cable routes, outlet locations and numbering[, **location of Consolidation Points**] and other detail necessary to document cable installation.
- C. **[Document interconnection between permanent link cabling from HC to Consolidation Points] and the cabling from the CP to the TO.**
 - 1. **Documentation shall be in the form of a spreadsheet which relates permanent link pair count with individual links to TOs.**
 - 2. **Base cable information on CP and TO designation and pair count.]**

END OF SECTION

SECTION 27 4100
AUDIOVISUAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. General provisions – Functional description of audiovisual systems.
 - 2. Product descriptions and requirements.
 - 3. Execution, standards, and commissioning requirements.
- B. Related Requirements
 - 1. Section 115213: Projection Screens
 - 2. Section 260500: Common Work Results for Electrical Systems
 - 3. Section 260961: Theatrical Lighting Controls
 - 4. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.

1.02 REFERENCES

- A. Definitions
 - 1. When the following abbreviations and definitions are used in relation to the work for this Section they shall have the following meanings:
 - a. AEI NW: Affiliated Engineers NW, Inc.
 - b. AHJ: Authority Having Jurisdiction
 - c. AV Consultant, Consultant, Engineer: AEI NW
 - d. AVSC: Audiovisual Systems Contractor
 - e. Boxes: Outlet, Junction or Pull Boxes
 - f. Code: All applicable codes currently enforced at project location
 - g. Compression: Compressed using leverage powered (hydraulic or equivalent) crimping tool.
 - h. Connection: All materials and labor required for equipment to be fully operational
 - i. Exterior Location: Outside of or penetrating the outer surfaces of the building's weather protective membrane.
 - j. Fully Operational: Tested, approved, and operating to the satisfaction of the AHJ, contract documents, and the Consultant.
 - k. Furnish: Deliver to the job site
 - l. Install: To enter permanently into the project and make fully operational.
 - m. Mfr.: Manufacturer
 - n. NEC: National Electrical Code, National Fire Protection Association, Publication #70
 - o. Noted: Shown or specified in the contract documents
 - p. Provide: Furnish and install
 - q. Required: As required by code, AHJ, contract documents, or manufacturer for the installation to be fully operational
 - r. Shown: As indicated on the drawings or details
- B. Reference Standards
 - 1. The referenced codes establish a minimum level of requirements. Where provision of the various codes conflict with each other, the more stringent provision shall govern. If any conflict occurs between referenced codes and this specification, the codes are to govern. Compliance with code requirements shall not be construed as relieving the AVSC from complying with any requirements of the drawings or specifications which may exceed the requirements of the governing codes and rules and not contrary to same.
 - 2. Perform all work and provide materials and equipment in accordance with the latest referenced codes and standards of the following organizations:

- a. ANSI - American National Standards Institute
 - b. ASTM - American Society for Testing and Materials
 - c. BICSI - Building Industry Consulting Services International
 - d. EIA - Electronics Industries Association
 - e. FCC - Federal Communications Commission
 - f. IBC – International Building Code
 - g. ICEA - Insulated Cable Engineers Association
 - h. IEEE - Institute of Electrical and Electronics Engineers
 - i. ISO - International Organization for Standardization
 - j. NEMA - National Electrical Manufacturer's Association
 - k. NFPA - National Fire Protection Association
 - l. NFPA 70 – National Electrical Code
 - m. NEC - National Electrical Code
 - n. TIA - Telecommunications Industry Association
3. Install the AV systems based on the following:
- a. ANSI/INFOCOMM Standard 2M-2010, AV Systems Design and Coordination
 - b. ANSI/INFOCOMM Standard 3M-2011, Projected Image Contrast Ratio
 - c. ANSI/INFOCOMM Standard 10.2013, AV Systems Performance Verification
 - d. ANSI/AVIXA Standard A102.01.2017, Audio Coverage Uniformity in Listener Areas
 - e. INFOCOMM Standard F501.01.2015, Cable Labeling for Audiovisual Systems
 - f. ANSI/AVIXA Standard V202.01.2016, Display Image Size for 2D Content in Audiovisual Systems
 - g. “Dashboard for Controls Design Guide”, April 2005, InfoComm International

1.03 SYSTEM DESCRIPTION

- A. The systems integrator will provide complete and working systems, based on the operational requirements set forth in the specification.
- B. Work Includes:
1. Provision of complete sound reinforcement, video presentation, audio and video teleconferencing, and control systems.
 2. Connection to and integration with other equipment provided by others including room lighting and shades.
 3. Generate all shop drawings and information for the complete installation and wiring of the system.
 4. Provide (or sub-contract for) the on-site installation and wiring and provide on-going supervision and coordination during the implementation phase.
 5. Initial adjustment of the systems as herein prescribed and provision of all test equipment for the system checkout and acceptance tests.
 6. Training in the operation and maintenance of the systems for personnel designated by the Owner.
- C. Contract Drawings:
1. The work of this Section and related sections is shown on the TA-xx series of drawings and equipment schedules.
 2. The drawings do not show all requirements of the specifications. The drawings and specifications are complementary and what is called for (or shown) in either is required to be provided as if called for in both. If in conflict, the specifications shall take precedence. Notify the Consultant immediately of any conflicts.
 3. Equipment racks, connection panels, and all other associated devices are shown diagrammatically only and indicate the general character and approximate location. Furnish, install, and place in satisfactory condition all AV equipment, cabling and all other

materials required for the systems shown or noted in the contract documents, so that it is a complete system which is fully operational and fully tested.

D. Operation:

1. General

- a. Provide for amplification of program audio sources and local sound reinforcement of presentations and classes.
- b. Provide display of video sources such as computers and video teleconferencing.
- c. Allow easy setup and operation of the audiovisual and sound reinforcement systems by a wide variety of users.
- d. System override from the fire alarm control panel in case of a fire or emergency. Activating the fire alarm system will automatically mute any audio sources in the system.

2. Room Descriptions

- a. Cafeteria/Meeting Room
- b. Huddle Spaces
- c. Conference Rooms
- d. Digital Signage

3. Audiovisual Control System

- a. The audiovisual systems will be configured from remote control panels located at the control room and a location near the stage. The control system will allow an operator to control the following:
 - 1) System ON/OFF
 - 2) Select system pre-sets such as Normal operation (which will require an operator to take over all controls) and Auto operation (which will engage the automix function of the DSP).
 - 3) Volume control of individual sources and master volume
 - 4) Video source selection and control
 - 5) Video display/projector control

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Conform to Section 013113 for coordination of work with other Sections.
2. The AVSC shall continually interface and coordinate the work with the work of other Contractors and/or other trades and shall examine all drawings and specifications of other trades including the mechanical, architectural, and structural for construction details and coordination.
3. Obtain submittals, shop drawings, and other information for all equipment to be furnished by the Owner or under other divisions of the specifications.
4. Prior to roughing-in, verify the exact location of all devices with Architect.
5. Provide coordination to the Owner in relation to special installation details associated with all AV hardware. This will include but is not limited to mounting details of loudspeakers, I/O panels, equipment, projectors, equipment racks, and any other project related coordination between the AV integration and building construction.
6. Special attention is called to the following items for coordination.
 - a. Conduit, cable tray, boxes, and other raceway components.
 - b. Location of casework, cabinets, counters, doors, and equipment racks so that all equipment is clear of and in proper relation to these items.
 - c. Mounting, recessing, and concealing cameras, video projectors, video displays, loudspeakers and loudspeaker clusters, and other associated equipment in specially constructed casework and niches.

7. The AVSC will not be paid for work associated with the relocation of equipment, conduits, cabling, or any other materials requiring removal or reinstallation resulting from a lack of coordination prior to installation.
- B. Pre-Installation Meetings
 1. Arrange in accordance with Section 013119
 2. Attendance: AVSC, installer, Owner, Architect, AV Consultant, and those requested to attend.
 3. Meeting time: Minimum four (4) weeks prior to beginning work of this Section and work of related Sections affecting work of this Section.
 4. Location: Project site.
- C. Sequencing and Scheduling
 1. Conform to Section 013216 for sequencing and scheduling to meet Progress Schedule Critical Path and long lead items.
 2. The AVSC shall schedule its work to prevent conflicts with other activities in the building and shall execute without claim for extra payment moderate moves or changes as are necessary to accommodate other equipment or preserve symmetry and pleasing appearance.

1.05 SUBMITTALS

- A. A complete set of submittal documents will include shop drawings, product data, and network device inventory, as described below, and submitted simultaneously for review and comment.
- B. Submit under provisions of Section 013300.
- C. The AVSC agrees that submittals and shop drawings processed by the AV Consultant are not change orders. The purpose of submittals and shop drawings by the AVSC is to demonstrate to the AV Consultant that the AVSC understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install, and by detailing the fabrication and installation methods he intends to use.
- D. The AVSC alone accepts all responsibility for assuring that all materials furnished under this Division of the specifications meet in full all requirements of the contract documents. The AV Consultant's review is for general conformance with the design concept and contract documents. Markings or comments shall not be construed as relieving the AVSC from compliance with the project plans and specifications, nor departures there from. The AVSC remains responsible for details and accuracy for confirming and correlating all quantities and dimensions, for selecting fabrication processes and for techniques of assembly.
- E. Submittals and shop drawings that are incomplete or that contain insufficient information will be returned without review, for re-submittal.
- F. Shop Drawings:
 1. Floor plans, showing the layout of devices, cabling, and wiring within raceway systems. Include the number of cables, type of cables, and size of raceway for each run.
 2. Wiring diagrams showing point to point connections between components. Include wire numbers and color-coding for each connection point, with numbers corresponding to those of the wire-run list.
 3. Rack panel layout for each equipment cabinet.
 4. Scaled and dimensioned drawings of all custom assemblies and fabricated items, including but not limited to the following. Include details of all components, materials, finishes, and colors.
 - a. Control panel mounting
 - b. Projector and display mounting frames and hardware
 - c. Input and output panels, including mounting of panels in casework.
 - d. Speaker clusters
 5. Preliminary cable numbering lists.

G. Product data:

1. Equipment list based on specified equipment list and other additional equipment or materials needed for complete systems. Include:
 - a. Manufacturer
 - b. Model number
 - c. Descriptions
 - d. Quantity
 - e. Specification reference
2. Product data by system or room, with brochures and/or catalog cuts for all items of equipment and hardware. Provide as PDF documents downloadable from the project website, on USB memory stick, or on CD/DVD ROM.
3. Provide a single product data sheet for any devices used in multiple rooms.
4. For each item, indicate listing by UL or other approved testing agency. For audio power amplifiers, indicate the NEC Class of output wiring.
5. Printouts from web pages are not acceptable.
6. Itemize variations from the specification in a separate enclosure. Refer to section, paragraph, and item of the specifications and clearly state the variation.

H. Networked Device Inventory

1. Inventory of all network-attached devices in the project. Include:
 - a. Device, manufacturer, and model number
 - b. Physical location
 - c. Default gateway IP address
 - d. Addressing scheme
 - e. IP address
 - f. Subnet mask
 - g. Host name
 - h. DNS server(s)
 - i. Ports required
 - j. Transport protocol
 - k. Multicast/Unicast
2. Provide Networked Device Inventory in Microsoft Excel 2010 format.

1.06 CLOSEOUT SUBMITTALS

- A. Conform to provisions of Section 017700.
- B. Maintenance and Operating Data and Instructions to Owner's Personnel: Conform to Section 017824.
- C. The AVSC shall prepare Operations and Maintenance Manuals for each system or facility provided under these specifications. The information included must be the exact equipment installed, not the complete "line" of the manufacturer. Where sheets show the equipment installed and other equipment, the installed equipment shall be neatly and clearly identified on such sheets.
- D. The manuals shall contain all the information needed to operate and maintain all systems and equipment provided in the project. It shall be presented and arranged in a logical manner for efficient use by the Owner's operating personnel. The information provided shall include but not be limited to the following:
 1. Equipment manufacturers, makes, model numbers, serial numbers, sizes, etc. Include addresses and telephone numbers for each manufacturer. List loose items separately.
 2. A copy of the delivery receipt for Loose Items.
 3. Description of system configuration and operation including component identification and equipment interconnect diagram.
 4. Manufacturers' recommended operation instructions for each item of equipment.

5. Overall system operating instructions, custom written for this specific project.
6. Warranty Information, including but not limited to:
 - a. An overall Statement of Warranty from the AVSC for the complete systems.
 - b. A copy of the Manufacturers' warranties for each item of equipment so covered.
 - c. Instructions for obtaining warranty service from the AVSC, and from each Manufacturer.
 - d. Service manuals for each item of equipment as published by the manufacturers, and other manufacturers' servicing data.
 - e. Complete parts list including reordering information, recommended spares and anticipated useful life (if appropriate). Parts lists shall give full ordering information assigned by the original parts manufacturer. Relabeled and/or renumbered parts information as reassigned by equipment supplier not acceptable.
 - f. "As-built" Shop Drawings, including point to point wiring diagrams.
 - g. "As-built" Cable Numbering Lists.
7. Service manuals for each item of equipment as published by the manufacturers, and other manufacturers' servicing data.
8. Complete parts list including reordering information, recommended spares and anticipated useful life (if appropriated). Parts list shall give full ordering information assigned by the original parts manufacturer. Relabeled and/or renumbered parts information as reassigned by equipment supplier not acceptable.
9. "As-built" Shop Drawings, including point to point wiring diagrams.
10. "As-built" Cable Numbering Lists.
11. Copies of all test results. Include the names of the individuals performing and witnessing the tests, and the manufacturer and model of each item of test equipment which was used. Include block diagrams of the test setup for tests which involve more than one item of test equipment.
12. Wiring diagrams for each system shall be complete drawings for the specific system installed under the contract. "Typical" line diagrams will not be acceptable unless marked to indicate the exact field installation.
13. Networked Device Inventory
 - a. Inventory of all network-attached devices in the project, including:
 - 1) Device Properties
 - 2) Manufacturer
 - 3) Model number
 - 4) Description
 - 5) Software version(s)
 - 6) Firmware version(s)
 - 7) MAC address
 - b. Inter-Device Communication
 - 1) Transport protocol
 - 2) Multicast/unicast
 - 3) Codec
 - 4) Incoming and outgoing peak bps
 - 5) Average incoming and outgoing bps
 - c. Routing and Addressing
 - 1) Physical location
 - 2) Default gateway IP address
 - 3) Addressing scheme
 - 4) IP address
 - 5) Subnet mask

- 6) Host name
 - 7) DNS server(s)
 - 8) Ports required
14. Provide Networked Device Inventory in Microsoft Excel 2010 format.
- E. The information contained in the manuals shall be grouped in an orderly arrangement by specification index. The manuals shall have a typewritten index and divider sheets between categories with identifying tabs. The completed manuals shall be bound in heavy-duty slant-ring binders (3 "D" rings), or with hardboard covers and screw-post bindings. O & M manuals shall not exceed 5" thickness. Provide two or more volumes if required. The covers shall be labeled with the name of the job, Owner, Architect, Engineer, Contractor and year of completion. The spine shall be labeled with the name of the job, Owner and year of completion. Labeling may be laser-printed inserts in clear plastic overlays or imprinting by silk-screening or hot stamping. Include the following information:
1. Project Title
 2. Project Number
 3. Owner/Operator (Owner's Name)
 4. Architect (Architect's Name)
 5. Engineer (AEI NW)
 6. Contractor
 7. Completion Date
- F. Submit a preliminary copy 15 days prior to substantial completion of the project for checking and review.
- G. Project Record Documents: Conform to provisions of Section 017839.
1. Continually record the actual "as-built" installation on a set of prints kept readily available at the project during construction. These prints shall be used for this purpose alone. At the completion of the work, Contractor shall furnish the Architect a set of reproducible record drawings (Xerox type) and the set of mark-ups. Final payment to the Contractor will not be authorized until these prints have been submitted to and accepted by the Architect.
 2. Record drawings shall include, at a minimum, updates of all sheets of the Shop Drawings.

1.07 QUALITY ASSURANCE

- A. Qualifications
1. Manufacturer's Qualifications: Firm (material producer) with not less than five years of production experience whose published literature clearly indicates general compliance of products with requirements of this section.
 2. Equipment Suppliers: Audio, video, and control components shall be supplied and installed by an authorized factory distributor of specified products. Submit statement of distributorship/dealership prior to acceptance of bid.
 3. AVSC Qualifications:
 - a. Work in this section shall be performed by an AVSC with the following qualifications:
 - 1) Complies with the requirements of Division 1.
 - 2) Is licensed to perform work of this type in the project jurisdiction
 - 3) Has at least five (5) years of verifiable direct experience with the devices, equipment, and systems of the type and scope specified herein.
 - 4) Fully staffed and equipped maintenance and repair facility.
 - b. The AVSC or their employees shall hold the following certifications:
 - 1) INFOCOMM CTS-D (Certified Technology Specialist-Design)
 - 2) INFOCOMM CTS-I (Certified Technology Specialist-Installation)
 - 3) Video switching and routing system
 - 4) AV control system programming
 - 5) Audio DSP Programming

- 6) Synergetic Audio Concepts Sound Reinforcement for Technicians
 - c. Provide copies of all certifications with bid
 - d. The AVSC shall be a factory-authorized dealer for the major components specified including items such as microphones, audio processing equipment, power amplifiers, loudspeakers, video interfaces, video switchers and processors, video displays, and integrated audiovisual control system.
 - e. The AVSC shall appoint a designated supervisor with the appropriate certifications. The supervisor shall be present and in responsible charge of all work in the fabrication shop and on the project site during all phases of the installation and testing of the system(s). To ensure continuity, this supervisor shall be the same individual throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.
 - f. The AVSC shall use skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work in this Section. These personnel shall have at least three years direct experience in similar work, evidence of which shall be verified in writing with appropriate references at the time of bid.
 - g. Other contractors bidding this work who cannot meet the above qualifications must employ the services of a qualified AVSC who meets the above qualifications. This AVSC shall supervise the installation and perform all wiring connections.
- B. System Performance Requirements
1. Audio System
 - a. Systems shall provide clear, natural sound uniformly distributed throughout the listening areas. The entire electro-acoustic system shall be carefully balanced and equalized to provide a high order of intelligibility and gain without feed back or reverberant coloration. Adequate power capability shall be provided to insure the necessary dynamic range and prevent distortion at peak levels.
 - b. Acoustic Frequency Response: 50 Hz to 15 kHz, 3dB/octave roll-off above 2000 Hz ± 2 dB. Measured at continuous one-third octave bands at seated ear height.
 - c. Sound System Coverage: as measured in accordance with ANSI/InfoComm A102.01:2017, Audio Coverage Uniformity in Listener Areas.
 - d. Intelligibility: Greater than 0.75 STI at any seat in the audience area.
 - e. Noise: System noise shall not exceed an equivalent input noise of -120dBu based on a 20 kHz noise bandwidth. Predominant noise component in the system output under any operating condition will be that of the input stages. Adjustment of any system controls shall produce no audible clicks, pops, thumps, or other spurious noises.
 - f. Acoustic Signal-to-Noise Ratio (including crosstalk and hum at all input/output levels): 60dB.
 - g. Dynamic Range:
 - 1) General: All systems shall include a 10dB peaking factor to any location at seated ear height and at less than 5% total acoustic harmonic distortion. When the system is driven to maximum output, clipping shall occur first in the power amplifiers.
 - 2) Conference Rooms: The system shall deliver a minimum sound pressure level of 75 dB
 - 3) Multifunction Rooms: The system shall deliver a minimum sound pressure level of 85 dB
 - h. Total Harmonic Distortion: 0.05% maximum from 20Hz to 20kHz.
 - i. Polarity: A positive pressure at any system microphone shall produce a positive pressure from the speakers.

2. Analog Video System
 - a. Systems shall provide, clear, bright, and natural images viewable throughout the respective designed viewing area. Each video display system shall be balanced for color and brightness and free from extraneous interference or artifacts.
 - b. Frequency Response:
 - 1) Composite: Flat from 30Hz to 6MHz, +/-2% (ref.=1MHz)
 - 2) YC: Flat from 30Hz to 10MHz, +/-2% (ref.=1MHz)
 - 3) Component: Flat from 30Hz to 100MHz, +/-2% (ref.=1MHz)
 - 4) RGBHV: Flat from 30Hz to 300MHz, +/-2% (ref.=1MHz)
 - c. Signal-to-Noise Ratio (including crosstalk and hum at all input/output levels): 60dB, p-p signal to RMS noise
 - d. Differential Gain: <2%
 - e. Differential Phase: <2 degrees at 3.58MHz
 - f. Tilt: <2%
 - g. System Gain: Unity, +/-1%
 - h. System Levels: <2% between sources
 - i. Timing: <20nS, Y/C, Y/Cr/Cb, RGB
 - j. Luminance: In conformance with NTSC RS-170A standards
 - k. Chroma level: In conformance with NTSC RS-170A standards
 - l. Observable noise or hum: None
3. Digital Video System
 - a. Audio & Video Switching
 - 1) Provide 12.8 Gbps of backplane throughput to support 1080p 36-bit (Deep) Color video resolutions without compression.
 - 2) Support at least 6.75Gbps of data transfer on each input and output to support 1080p 36-bit (Deep) Color video resolutions without compression.
 - 3) Support 8 channel audio.
 - 4) Support audio breakaway from video.
 - 5) Insert less than 5us of latency from AV input to AV output.
 - 6) Support the HDMI specification of less than 1 in 1×10^{-9} bit errors at 1080p 36-bit (Deep) Color.
 - 7) Down-mix multi-channel audio into 2-channel audio to route audio content to both multi-channel and 2-channel sinks.
 - 8) Dither between standard and deep color video signals on each input and output.
 - 9) Support the following AV signal inputs:
 - a) HDMI 1.3a (High Definition MultiMedia Interface)
 - b) DVI 1.1 (Digital Visual Interface)
 - c) Display Port Multimode 1.1
 - d) Analog RGB
 - e) YPbPr
 - f) S-Video
 - g) CVBS
 - h) SPDIF
 - 10) Analog Stereo Audio
 - 11) Transcode and scale the AV signals to a single signal type for distribution.
 - 12) Support the following digital video formats and data rates (Gbps)
 - a) 1080p Deep Color: 6.75
 - b) 1600x1200: 4.86
 - c) 1920x1200: 4.62
 - d) 1080p: 4.44

- e) 1360x768: 2.54
 - f) 720p/1080i: 2.22
 - g) 1024x768: 1.91
 - 13) Audio & Video Signal Distribution
 - a) Route AV signals from any input to any output.
 - 14) Use shielded twisted pair structured cabling to carry the AV signals.
 - 15) Use shielded twisted pair structured cabling specified to 1.2GHz of bandwidth or greater.
 - 16) Transmit the following control signals for AV sources and sinks over the same cable plant:
 - a) RS-232
 - b) Infrared
 - c) Ethernet
 - d) USB Human Interface Device-class devices
 - e) Contact closure
 - 17) EDID Management
 - a) Allow configuration of the EDID presented to sources on each AV input.
 - b) Configure each input independently.
 - c) Present an EDID to each input that includes only the video timings and audio formats common all sinks connected to the outputs.
 - d) Allow the user to enter each input's EDID video timings individually.
 - e) Allow the user to enable and disable support for the following items in each input's EDID.
 - f) Deep color
 - g) 3D support
 - 18) HDCP Management
 - a) Support HDCP 1.1 or greater.
 - b) Detect the number of KSVs supported by each source.
 - c) Cache the KSVs from each connected sink.
 - 19) Signal Detection
 - a) Report the following incoming signal information to an AV control system:
 - b) Signal detect
 - c) Horizontal and vertical resolution
 - d) Signal refresh rate
 - e) Presence of HDCP
 - 20) Report the following information to an AV control system:
 - a) HDCP authentication status for each source and sink
 - b) EDID Preferred video timing for each sink
- C. Control System
1. System shall utilize a remote-controlled switching and processing system for control of audiovisual system components.
 2. The system shall provide controls for selecting system on/off, audio and video input selection, audio volume, signal routing and processing, codec connection and volume, projection screen up/down, projector lift control, camera control, and lighting control.
 3. User Interfaces:
 - a. The control panel interface layout will conform to the InfoComm International "Dashboard for Controls Design Guide", published April 2005.
 - b. Control system user interface conforms to control functions described in Paragraph 1.4 D.5 of this specification, and with the Owner's standard classroom AV control

panel interfaces to the greatest extent possible and all pages and buttons operate as intended.

4. Connections to other systems:
 - a. All IP-controlled equipment properly configured with IP addresses, host names, time servers, gatekeeper addresses, network configurations, and subnets as applicable. All system connections are operational and devices communicating correctly.
 - b. All control system programming installed and communicating properly with the equipment as intended.
 - c. Confirm control system interfaces exist and are functional for devices outside the scope of this section such as activation of lighting control presets, drapes, shades, screens, security, life safety, and HVAC systems.
5. Power Cycling: Confirm the control system will restart and resume full operation following cycling of AC power to the control system.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and acceptance requirements
- B. Storage and handling requirements
- C. Packaging waste management

1.09 SITE CONDITIONS

- A. Ambient Conditions: Verify field measurements before beginning fabrication or installation.

1.010 WARRANTY

- A. Refer to warranty provisions specified in Section 017836.
- B. Manufacturer: Include all provisions of the standard manufacturer's backed warranty for each piece of equipment and remain in effect for a period as stated by the manufacturer. AVSC shall be an authorized service representative for all equipment supplied as part of this project unless appropriate approval from owner has been granted prior to equipment procurement or installation. The warranty shall also cover the accuracy of technical documentation, and signal quality as specified and documented during the testing process of this project.
- C. AVSC: Guarantee all work installed under this specification. Make good, repair or replace, at the Contractor's own expense, any defective work, materials or parts which may show themselves within one year after final acceptance, if in the opinion of the Architect or Engineer said defect is due to imperfection in material, design, or workmanship.
- D. During the warranty period, respond to any warranty calls within four hours of having received and logged any requests for service.
- E. Special Warranty: Provide the cost of an additional one-year warranty beyond what is described in this specification.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Quality of Materials and Equipment
 1. All materials and equipment supplied by the Contractor shall be new and shall meet or exceed the latest published specification of the manufacturer in all respects.
 2. At the time of submittal, the Contractor shall supply the latest model for each piece of equipment.
 3. All equipment shall be UL listed, or equivalent.
- B. Manufacturer:
 1. All accessories, including rack mounting hardware, power supplies, etc., shall be obtained from the original equipment manufacturer. Unless otherwise noted or specified, third party accessories shall not be used.

2. Do not provide an assortment. For each category, provide products of the same manufacturer; for each item, provide the same model for all pieces.
- C. Substitutions:
1. Substitutions of equal equipment beyond the alternatives listed will be permitted only when approved prior to bidding, in accordance with the procedures given in Section 012513 – Product Substitution Procedures.
 2. Submit requests for substitutions for products prior to bid. All requests must be received by the Owner in writing no later than **[10]** days prior to bid date.
 3. Itemize any variation from the specifications. For each item, refer to the pertaining Section and Paragraph, and indicate the reason for, and/or the advantage of, the substitution.
 4. Substitutions will not be accepted if they impact overall system design and functionality.
 5. Requests for substitution which do not comply with these requirements will not be considered.
- D. Product Options:
1. Where these specifications include model or series numbers, the provided equipment (including substitutions) shall meet or exceed the manufacturer's published specifications for the specified model or series the same as if the manufacturer's published specifications were enumerated within these project specifications.
 2. This requirement is in addition to the other requirements given in the project specifications.
 3. This requirement is not intended to apply to characteristics (such as color or appearance) which do not affect the performance, function, or reliability.
- E. Owner-Furnished or Owner-Supplied Equipment
1. The AVSC, as needed, shall be responsible for removing and/or obtaining OFE equipment from the Owner's location and transporting it to his shop. At the AVSC's facility, he shall ascertain that the OFE equipment is performing at or above factory specifications.
 2. If the equipment is not operating "as-new" or is missing accessories necessary to properly integrate the equipment into the system as intended, the AVSC shall provide a proposal, including a time line, for returning the equipment to "as-new" condition and providing the needed accessories.
- F. Wireless Equipment: Prior to ordering equipment, the AVSC shall coordinate the frequencies of all wireless devices to prevent unwanted interaction between devices and rooms. This includes, but is not limited to, wireless microphones, assisted listening system devices, wireless control panels, etc.
- G. Spare Parts: Provide one full set of spare video projector lamps.

2.02 EQUIPMENT SCHEDULE

- A. Refer to the attached Equipment Schedule, 274100.1.

2.03 EQUIPMENT RACKS

- A. Provide hardware as required to provide finished install of specified racks, doors, rack rails, side panels, top and bottom sections, fans, etc.
1. Where racks are shown together, gang together using factory-provided hardware.
- B. Provide hardware as required for standard 19" rack mounting of equipment.
1. Equipment that does not include manufacturer-provided rack hardware shall utilize a factory-made rack-mount kit such as manufactured by Middle Atlantic Products.

2.04 POWER DISTRIBUTION

- A. Provide plug strips or plug mold as required to connect AC power to all associated equipment in racks, equipment consoles and custom mounting enclosures. Provide a minimum of one plug strip or plug mold per rack.
- B. Provide master power control and sequencing equipment, to be controlled by the AV Control System.

- C. Where applicable use rack manufacturer part or plug strip kit.

2.05 CABLE

- A. Refer to the attached schedule, 274100.2: Cables and Connectors
- B. Provide wire and cables which are UL-listed and marked for their Class of wiring, per NEC.
- C. Trade numbers shown are for general-purpose cables for use in raceway and where otherwise allowed by NEC and other codes. Prior to installation, the AVSC shall verify, for each installation situation, with the local authority having jurisdiction that non-plenum and non-riser rated cables are acceptable. If plenum or riser-rated cables are required, provide cables so rated with equivalent electrical characteristics to those specified below.

PART 3 - EXECUTION

3.01 GENERAL

- A. Conform to manufacturer's instructions and provisions of Contract Documents. Where in conflict, assume requirements that are more stringent and verify with Architect before beginning work.

3.02 EXAMINATION

- A. Verification of Conditions: Verify conditions as satisfactory to receive work of this Section before beginning.
- B. Pre-Installation Testing
- C. Evaluation and Assessment

3.03 PREPARATION

- A. Protection of In-Place Conditions
- B. Surface Preparation
- C. Demolition/Removal

3.04 INSTALLATION

- A. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors.
- B. Equipment Mounting
 - 1. Equipment (except portable equipment) shall be firmly held in place. Fastenings and supports shall be adequate to support their loads with a safety factor of at least three. Equipment shall be braced for seismic conditions according to applicable codes and regulations.
 - 2. Rack-mounted equipment:
 - a. Install vent panels between amplifiers.
 - b. Install blank panels to fill any unused rack spaces.
 - c. Mount mixers, controls, and patch panels at working height.
 - d. Within racks, install cables and wiring neatly, forming straight lines and smooth corners. Bundle separately, or install in separate plastic ducts, the microphone, line-level audio, speaker, control, video, and power wiring.
 - 3. Loudspeakers:
 - a. Do not support speaker enclosures with lay-in tiles or GWB. Provide adequate support (using attachments to structural elements and/or metal mounting bars) for back-boxes so that no perceptible sag will occur once speaker and grille are mounted. Assume a loudspeaker weight of 10 pounds, at a minimum.
 - b. Caulk enclosures to ceiling surface (e.g. lay-in tile or GWB) to form an airtight seal.
 - c. Verify polarity of each speaker voice coil prior to installation and connect to maintain uniform polarity.

- d. Tap 70-volt transformers as shown, or to provide an amplifier load between 60% and 90% of rated capacity with all speaker-line attenuators (if any) set for minimum attenuation.
 - e. Install speaker and baffles to provide tight seal with ceiling and enclosure. Do not caulk baffle to ceiling.
 - f. Install so speaker grille is centered in tile or building element, with sides of grille or line between mounting fasteners parallel to ceiling grid or building lines.
- C. Raceway
1. Install wire and cable only within raceway systems. Do not install wire or cable in wall cavities or ceiling plenums/attic spaces without the use of raceway (conduit or cable tray), without the explicit written permission of Owner, or as otherwise noted on the drawings.
 2. Maintain conduit fills equal to or less than those given by Table 1 of Chapter 9 of the NEC, regardless of the class of wiring.
- D. Cable Installation
1. Install wire and cable only within the raceway systems provided under Division 26. Do not install wire or cable in wall cavities or ceiling plenums/attic spaces without the use of raceway (conduit or cable tray) unless otherwise noted on the drawings.
 2. Maintain conduit fills equal to or less than those given by Table 1 of Chapter 9 of the NEC, regardless of the class of wiring.
 3. Use only cable lubricants that are compatible with the jacket materials.
 4. Upon completion of pull, clean exposed cables and surfaces to be completely free of lubricant and residue.
 5. Protect installed conductors from painting, overspray, and taping or patching compounds.
 6. Cable splices are allowed only in accessible junction boxes, using insulated crimp-on connectors, soldering covered with heat shrink, or other methods approved by the Engineer.
 - a. Do not splice in conduits or cable tray.
 - b. Splicing with wire nuts is prohibited.
 7. Install cables and wiring neatly, forming straight lines and smooth corners, without deformation, kinks, scrapes, or cuts of the jacket or insulation.
 - a. Maintain the minimum bend radius of cables as recommended by the manufacturer.
 - b. Do not use cable ties in the cable tray or overhead junction boxes, except where otherwise shown or otherwise directed in writing by the Engineer.
 - c. Do not cinch cable ties tightly; leave loose enough so each cable can be easily moved through the cable bundle. There should be no deformation of the outer cable jacket.
 - d. Where installed without raceway, support cables with D-rings or J-hooks at minimum intervals of 24". Do not put J-hooks at equal distances; space randomly.
 - e. Where bundles are subject to flexing, enclose bundle with nylon webbing or spiral wrap; do not use cable ties.
 - f. Where cables are installed vertically, provide support at regular intervals. Maximum distance between supports shall not exceed 80 percent of the manufacturers' recommended maximum vertical drop, or 50% of the recommended maximum pulling tension, whichever is less.
 - g. At a minimum, support cables at each floor with clamping strain relief.
 8. Cable assemblies run in conduit and/or cable trays should provide for a minimum of five (5) feet of excess cable on each end to allow for relocation of equipment or re-termination of cable in the future.
- E. Signal Separation:

1. All AV system cables shall be grouped according to the signals being carried and installed in separate raceways. To reduce signal contamination, separate groups shall be formed for the following cable families:
 - a. Audio cables carrying signals less than – 20dBm (microphone circuits)
 - b. Audio cables carrying signals between – 20dBm and +20dBm (analog line-level circuits)
 - c. Audio cables carrying signals above +20dBm (including Class 1 and Class 2 loudspeaker circuits)
 - d. Analog video and broadband CATV cables
 - e. Digital audio, video, network, or telephone cables
 - f. Power and lighting cables
 - g. Control cables
 2. Minimum separation from other circuits:
 - a. From power and switched lighting circuits: at least 24".
 - b. From dimmed lighting circuits: at least 48".
 - c. Where runs are adjacent for less than 80 ft, the required spacing may be halved (12", or 24" from dimmed lighting circuits).
 - d. Where runs are adjacent for less than 6 ft, or where circuits cross at right angles, separations of 2" may be used.
 - e. Where AV circuits cross or intersect with power or lighting circuits, cross at 90 degrees (plus or minus 2 degrees) to the greatest extent possible.
- F. Rack Cable Installation
1. All cable entry shall be through the tops of racks or through entrance holes in the base of the rack. No cable shall enter racks through front, rear, or side panel openings.
 2. Cables shall not protrude from the back of racks.
 3. Where bundles enter racks, arrange neatly without crossovers. Secure cable bundles within racks and equipment consoles with Velcro cable ties.
 4. As a general practice, all power cables, control cables, and high-level cables shall be run on the left side of an equipment rack as viewed from the rear. All other cables shall be run on the right side of an equipment rack, as viewed from the rear.
 5. Inside each rack, cables ties shall be placed at appropriate intervals of no greater than six inches for vertical bundles and no greater than two inches for horizontal bundles.
 6. All vertical cable bundles shall be attached to the rack frame.
 7. Provide flexible service loops for cable assemblies so that equipment in racks or equipment consoles can be fully pulled out for service without cutting wire ties or putting undue stress on cable assemblies. This includes:
 - a. Equipment in casework or racks which have less than 1 meter of clearance for rear access.
 - b. Equipment with sliding mounting hardware.
- G. Connections and Terminations
1. Prior to connection, verify freedom from shorts or grounds of all conductors (including shields and drain wires) of all cables.
 2. All cables shall have proper connector housing.
 3. All AV system wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means.
 4. Serve shielded cables with heat shrink tubing to insulate shield and drain wire. Unused wires at the end of a cable shall remain un-stripped and shall be laid back and held in place with wire ties.
 5. Make connections to plugs, receptacles, connectors, or solder terminals with rosin-core solder using temperature-controlled solder stations.

6. Ensure that no un-insulated wire is exposed beyond its pin.
 7. Utilize only multi-core flux resin with 60/40 tin-lead non-corrosive construction, designed for electronic equipment use.
 8. Soldering shall utilize good engineering practices and completed solder connections shall appear shiny and smooth with no visible imperfections, cracks, or cold-solder joints.
 9. Make connections to screw connections using insulated spade lugs or Phoenix-style connector blocks. Ensure that no un-insulated wire is exposed beyond its pin.
 10. For all crimp-type connectors and pins, utilize only crimp tools rated for the crimp pin type, size and wire gage being assembled. Consult the manufacturer's specifications and recommendations for crimping.
 11. Utilize only gold-plated crimp pins.
 12. If a signal path requires that the signal pass through more than one device, each device must have looping input capability, or a distribution amplifier must be used to feed the signal to the devices. Do not use a video "T" in place of a video distribution amp to route signals to more than one device.
 13. All audio circuits shall be balanced (high, low, shield) except where otherwise indicated. Where cable runs between equipment exceed 20 feet, balance boxes shall be used to convert unbalanced circuits to balanced circuits.
 14. Wire all three and five pin audio connectors and quarter-inch phone jacks (mono and stereo) in accordance with IEC-268.
 - a. For three pin connectors, Pin 1 is ground, Pin 2 is positive, and Pin 3 is negative.
 - b. For five pin connectors, Pin 1 is ground, Pin 2 is left positive, Pin 3 is left negative, Pin 4 is right positive, and Pin 5 is right negative.
 - c. For quarter-inch stereo phone jacks, Tip is positive, Ring is negative, and Sleeve is ground.
 - d. For quarter-inch mono phone jacks, Tip is positive, and Sleeve is ground.
 15. The strain relief of the connector shall fully engage cable jacket.
- H. Wire Numbering
1. Develop a wire numbering system to uniquely identify each AV cable.
 2. Number or color code individual conductors of cables to identify circuits and connections.
 3. Record number and color codes on the "AS-BUILT" drawings.
 4. For each system, include the following on the wire run list, for each cable:
 - a. Cable number
 - b. Signal type
 - c. Cable type
 - d. "To" destination
 - e. "From" destination
 - f. Room and equipment location for both ends of the cable
 - g. Approximate length of cable run
 5. Provide the cable numbering list as a computerized spreadsheet, in a format compatible with Microsoft Excel (version 6.0 or higher). As part of the O&M Manuals, provide:
 - a. Printed copies in each Manual.
 - b. One set of electronic files, on CD-ROM in a format compatible with IBM-PCs.
- I. Cable Labeling
1. Label all cabling in conformance with INFOCOMM Standard F501.01:2015, Cable Labeling for Audiovisual Systems.
- J. Grounding and Shielding
1. Rack Grounding:

- a. Install a single-point grounding system for each system. Where multiple systems are installed in a single grouping of racks, they shall be considered one system for grounding purposes.
 - b. Verify integrity of grounding systems and isolated receptacles prior to connection of equipment.
 - c. Prior to installing or connecting equipment, temporarily disconnect ground wires (installed under Division 26) from equipment cabinet(s), and measure impedance between each ground wire and its cabinet. Verify electrical isolation (minimum resistance of 1 Megohm) between rack cabinets and raceway and conductive structure. Record results for test report. Reconnect ground wires.
2. Connect shield and grounding conductors as follows:
- a. Connect shields of microphone wiring to receptacle and patch panel common.
 - b. Insulate shields from connector shell, plates, boxes, and raceway.
 - c. Connect shields of wiring from patch panel to control console inputs only to control console (insulate at patch panel).
 - d. Connect shields of balanced line level circuits at patch panel only; insulate at the opposite end of the cable. For balanced circuits that do not terminate at patch panels, connect shields at input ends only; insulate at output ends. Use this standard as needed to correct ground hum issues.
3. Maintain shield and drain wire continuity through junction boxes and intermediate termination points. Insulate shields from raceway or other conductive building elements. Maintain shields to within 3 inches of connected devices and maintain twisting of pairs of wires to within 1/2 inch of connector or device termination.
4. Make any modifications to grounding and shielding which are necessary to eliminate extraneous noise and RFI, prevent parasitic oscillations, and other signal instabilities, and to meet overall systems noise specifications. Record any deviations from the above guidelines, and the reasons that each deviation was deemed necessary.
5. Do not remove or defeat grounding terminal of 3 conductor power cords and maintain safety grounding and bonding as required by the NEC.
6. The overall governing requirements are that the wiring systems shall not induce or pick up perceptible noise, and that the predominant components of the noise floor of all signal paths shall be normal "thermal" noise of the upstream devices.
7. Because of the great number of possible variations in grounding systems, it shall be the responsibility of the AVSC to follow good engineering practice, as outlined above, and to deviate from these practices only when necessary to minimize crosstalk and to maximize signal-to-noise ratios in the audio, video, and control systems.
- K. Interface with Other Work
- L. Cutting Building Construction
1. Obtain permission from the Architect or Owner and coordinate with other trades prior to cutting. Locate cuttings so they will not weaken structural components. Cut carefully and only the minimum amount necessary. Cut concrete with diamond core drills or concrete saws except where space limitations prevent the use of such tools.
 2. All construction materials damaged or cut into during the installation of this work must be repaired or replaced with materials of like kind and quality as original materials by skilled labor experienced in that building trade.
- M. Penetrations of Fire Rated Elements
1. Must be provided such as to retain that rating.
- N. Painting
1. The AVSC will repaint or arrange to repaint existing building components such as walls, frames, etc. which are scratched or marred by the AVSC during installation.

2. The AVSC will repaint or refinish equipment, loudspeaker grilles, microphones, or other AV system components which are scratched or marred by the AVSC during installation.

3.05 SYSTEM START-UP

- A. System Start-Up: Conform to provisions of Section 017500.

3.06 SYSTEM TESTS AND ADJUSTMENTS

- A. Inspect and adjust after installation.
- B. Repair or replace defective equipment or installations.
- C. Testing and adjustment of equipment shall be performed by qualified technicians with general knowledge of video and audio systems alignment and trouble shooting, and knowledge of specific equipment and systems in this project.
- D. Manuals: All manufacturers' maintenance or alignment manuals shall be present during testing and adjustment procedures.

3.07 TEST EQUIPMENT

- A. Test Equipment:
 1. Test equipment shall be in good mechanical and electrical condition.
 2. Non-professional test equipment or home-built kit equipment is not acceptable.
 3. This list constitutes the minimum instrumentation required to perform the tests in the checklists and does in no way imply a comprehensive list for engineered AV systems testing. Additional instrumentation may be required to verify performance on an item of equipment, or to quantify environmental and other issues to expedite corrective actions by others.
 - a. Sensitive AC voltmeter, -80 dBu sensitivity, 20-30 kHz response, able to measure signal to noise ratio, THD, electrical audio levels within the system. Note that some systems require measurements up to 100 volts and may require an external pad.
 - b. Sound pressure level meter, ANSI Type II, with A and C weighting filters, fast or time-averaged.
 - c. Audio signal generator, 20-30 kHz, sine wave, pink noise.
 - d. Amplified loudspeaker 100 mm producing 60 dBA at one meter, and 70 dBA at one-meter, pink noise, sine wave, speech files.
 - e. 200 MHz oscilloscope, with TV sync.
 - f. Analog video signal generator NTSC/PAL, plus computer patterns at all required resolutions and refresh rates required for the systems under test. For systems with composite video, include PLUGE pattern.
 - g. Digital video signal generator for computer patterns for all resolutions and refresh rates required for the systems under test, HDMI/DVI.
 - h. The ability to measure STI-PA (source and analyzer).
 - i. Colorimeter/luminance meter, 10% accuracy.
 - j. Infrared thermometer.
 - k. Test media with known levels (audio, video, etc.): CDs, VHS, DVDs, etc.
 - l. AC/DC multimeter.
 - m. Light meter, lux/foot-candles.
 - n. Outlet tester (to test power outlet wiring).
 - o. Cable sets, cable assemblies, adapters as required to sample and measure in or out of circuit as required.
 - p. Patch and jumper cables
 - q. Reference standards required for testing
 - r. Software to adjust remotely controlled signal processors, with necessary computer and related hardware. Provide enough cabling to permit controlling computer to be in loudspeaker service areas while signal processors remain in equipment cabinets.

- B. Test Instrument Calibration
 - 1. Testing firm shall have calibration program which assures test instruments are maintained within rated accuracy.
 - 2. Accuracy shall be directly traceable to the National Institute of Standards and Technology (NIST).
 - 3. Instruments shall be calibrated in accordance with the following frequency schedule:
 - a. Field instruments: Analog, 6 months maximum; Digital, 12 months maximum.
 - b. Laboratory instruments: 12 months.
 - c. Leased specialty equipment: 12 months where accuracy is guaranteed by lessor.
 - 4. Dated calibration labels shall be visible on test equipment.
 - 5. Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.
 - 6. Up-to-date instrument calibration instructions and procedures shall be maintained for test instrument.
 - 7. Calibrating standard shall be of higher accuracy than instrument tested.

3.08 MEASUREMENTS AND PERFORMANCE TESTING

- A. Verify that the systems are in conformance with the performance criteria in Section 27 41 00 – Audiovisual Systems, paragraph 1.9.B and 1.9.C.
- B. Work Includes:
 - 1. Provide all test equipment necessary for system checkout and acceptance tests.
 - 2. Perform initial system testing and adjustment as herein prescribed.
 - 3. Prepare and submit Audiovisual System Testing Report. Use 27 4100.3 – Audiovisual Systems Commissioning Checklist.
 - 4. Participate in and assist with operational system commissioning as herein prescribed.
- C. Successful completion of tests and inspections shall determine suitability for first beneficial use by the Owner.
- D. Systems to be inspected and tested:
 - 1. Sound systems, including:
 - a. System inputs and outputs
 - b. Wired and wireless microphone systems
 - c. Audio program sources
 - d. Preamplifiers, mixers, analog signal processors, and digital signal processors
 - e. Audio signal distribution network
 - f. Distribution amplifiers and power amplifiers
 - g. Loudspeakers
 - h. Assistive listening systems
 - i. Recording equipment
 - 2. Video presentation systems, including:
 - a. Video program sources
 - b. Video switchers and routers
 - c. Video signal processing equipment
 - d. Video distribution equipment
 - e. Video displays and projection systems
 - 3. Digital signage systems
 - a. Content management software
 - b. Audiovisual signal acquisition interfaces
 - c. Digital signage servers
 - d. Digital signage distribution
 - e. Video displays
 - 4. Audiovisual control systems

- a. Control system network
 - b. Control system processors
 - c. Control system interface panels
 - d. Control system software interfaces
- E. The AVSC shall:
1. Coordinate testing schedule with Construction Manager, Owner, and Engineer.
 2. Notify Owner and Engineer two weeks before testing.
 3. Perform initial system testing and adjustments.
 4. Prepare test results with comparison to specified performance and technical requirements, industry standards, and manufacturer's values and tolerances.
 5. Assure system equipment is installed in accordance with contract documents, is operational, and within industry and manufacturer's tolerances.
 6. Participate in and assist with systems acceptance testing.
 7. Assure suitability for operation.
- F. The Engineer shall:
1. Participate in and assist with systems acceptance testing.
 2. Recommend acceptance or rejection of the installed systems prior to final completion.
- G. The Construction Manager/Owner shall:
1. Ensure facilities are ready for the work described in this section.
 2. Participate in and assist with systems acceptance testing.
- H. Preliminary Systems Testing and Adjustment Report
1. Provide one copy of preliminary testing report in Acrobat PDF format. Test report shall include the following:
 - a. Signed statement on Contractor's letterhead that preliminary systems testing, and adjustment has been completed and the system is ready for acceptance testing by the Engineer.
 - b. Completed AV Systems Commissioning Checklist for each system or room.
 - c. Recorded measurements of all systems.
 - d. List of equipment used to perform tests. Identify the following:
 - 1) Type
 - 2) Manufacturer
 - 3) Model number
 - 4) Serial number
 - 5) Date of last calibration
 - 6) Documentation of calibration leading to NIST standards
 - e. Name(s) of personnel performing tests
 - f. Signature of project manager responsible for performance and oversight of system testing and adjustments.
 2. Provide completed reports to Engineer no later than 10 days after completion of checklists, testing, and adjustments unless otherwise directed.
- I. Audio:
1. Verify that the system is completely free from hum, noise, parasitic oscillation, and RFI.
 2. Measure and record the impedance of each speaker load at the main junction box or rack cabinet and total load on each amplifier. At a minimum, make measurements at 100, 1000, and 10,000 Hertz. Make corrections as required so that the load impedance of each loudspeaker circuit is equal to or greater than rated load impedance of the amplifier.
 3. Verify that positive pressure at any microphone produces positive pressure from each loudspeaker. Verify that signal polarity is correct and consistent for all circuits and paths. Reverse polarity if required, and record which circuit was reversed.

4. With signal processors in bypass mode, adjust gain controls so all components except power amplifiers reach rated nominal output simultaneously. For components which have rated maximum outputs between 18 and 25dBm and line level inputs, adjust each component for unity gain.
5. Set audio distribution amplifiers for unity gain unless otherwise specified by the Engineer. Record final settings of each unit.
6. Adjust power amplifier input attenuators so power amplifiers reach clipping at 10dB above 0VU on the mixing console output meter.
7. Re-adjust gains if required for proper operation of each system and component. Measure and record any such re-adjustments; also record the reason adjustment was deemed necessary.
8. Measure and record the electronic signal-to-noise ratio of each complete signal path with all microphone inputs at full gain, or at gain settings which correspond to the onset of ringing for a single microphone, whichever is lower gain, and other controls at normal settings. During test, terminate microphone receptacles with 200-ohm resistors.
9. Adjust bandwidth, filter slopes, time offset correction, and signal levels of each crossover. Measure and record final settings of each unit.
10. Adjust equalizers to optimize the specified frequency responses. Measure and record the electronic frequency response and the acoustic frequency response of the system before and after adjustments.
11. Adjust time delay units to shift the apparent acoustic origin to the main loudspeakers. Measure and record delay settings for each circuit.
12. Adjust automatic mixers, automatic level controllers, and other signal processors to optimize use of microphones for speech using the expected (normal) microphone positions.
13. Measure and record the impedance of each speaker load at the main junction box or rack cabinet and total load on each amplifier. At a minimum, make measurements at 100, 1000, and 10,000 Hertz.
14. Make corrections as required so that the load impedance of each loudspeaker circuit is equal to or greater than rated load impedance of the amplifier.
15. Slowly sweep all low frequency and full range speaker systems with sine waves at 25% of rated maximum amplifier power output, or at 50% of rated continuous power capacity of loudspeakers, whichever is less, from 20 Hz to 20 kHz. Observe for audible or perceptible vibration or rattling of speaker components, mounting apparatus, or building elements. Under this Section, correct vibration or rattling of speakers or mounting apparatus to the satisfaction of the Engineer. Report vibration or rattling of other building elements to the Engineer; include frequency, characterization of observed rattling or vibration, and recommendations for correcting the rattling or vibration in the report.
16. Measure and record the maximum sound pressure level of pink noise at onset of amplifier clipping. Make measurement using both A-weighted and un-weighted (flat) settings of the Sound Level Meter (SLM).
17. Measure and record the acoustic frequency response of the system at the four corners of the seating area, in the middle of the seating area, and at the middle rear of the seating area.
18. Measure and record the acoustic frequency response at each location provided in the Audio Coverage Uniformity Plan (ACUP)
19. Measure and record the speech intelligibility of the system at each location listed above (or each location provided in the ACUP).
20. Perform tests with the measuring microphone at the seated ear height of the audience, within designated seating areas. All interior finishes and furnishings shall be in place during measurements.
21. Make the above measurements for all loudspeaker systems.

22. Set gain of initial input stage to match nominal output level of program sources (Microphones, wireless receivers, program sources, etc.)
 23. Perform final equalization in the presence of the Engineer.
- J. Video
1. Verify that all signals comply with the recommended manufacturer's specifications for each item of equipment.
 2. Observe each signal for AC hum or noise. Correct as required so that no hum or noise is either visible in the displayed pictures or detectable on a scope.
 3. Set signal levels to NTSC RS-170A specifications for luminance level and chroma level, gain and phase.
 4. Test signals for differential phase, differential gain, chrominance to luminance delay, multi burst frequency response and signal to noise ratio.
 5. After equipment alignment, check all signal paths from the most up-stream point in the system to verify unity gain at the final destination. Set all equalizing video distribution amplifiers to achieve correct luminance and chrominance gain at each signal destination.
 6. Measure and record initial conditions for black level, gain level, color level values, tint and gray scale values prior to making any adjustments.
 7. Measure and record final conditions for black level, gain level, color level values, tint and gray scale values after making any adjustments.
- K. Digital Video
1. Demonstration and acceptance tests shall be done by a Crestron DMC-E Certified Engineer.
 2. Verify the AV switching equipment has been installed and configured correctly. Measure and record the following information in electronic format:
 - a. Number of HDCP KSVs "Keys" supported by each source
 - b. Video timing, HDCP use, and audio format of each source when operating
 - c. Video timings and supported audio formats for each connected sink
 - d. Video timings and supported audio formats presented in the EDID to each source. The preferred video timing shall be indicated.
 - e. Cable length on all shielded twisted pair cable used for AV distribution
 - f. Data rate supported by each shielded twisted pair cable used for AV distribution
- L. Control Systems
1. Verify all systems connections are operational and devices pass signal as specified.
 2. Audio and video network devices: Verify all IP-connected signal processing equipment is properly configured with IP addresses, gatekeeper addresses, network configurations, and subnets as applicable.
 3. Control system network devices: Verify all IP-connected signal processing equipment is properly configured with IP addresses, gatekeeper addresses, network configurations, and subnets as applicable.
 4. External devices:
 - a. Applies to drapes, shades, screens, lights, security, life safety, and HVAC systems or devices.
 - b. Confirm all external devices and systems operate as specified prior to connection to AV control system.
 - c. Confirm control system interfaces exist and are functional.
 - d. Confirm control system functions not obvious from control flow diagrams.
 5. Control system communications: Confirm all control system programming installed and properly communicating with intended equipment or systems.
 6. Control system user interface:
 - a. Confirm user interface conforms to user or specified requirements.

- b. Confirm all pages and buttons operate as intended.
7. Control system power cycling and recovery: Confirm control system will restart and resume full operation following cycling of AC power to the control system.
8. Document results of all system testing.

3.09 SYSTEM ACCEPTANCE TESTING

- A. When the work is complete and ready for Acceptance Testing, notify the Architect and the Consultant in writing. Include copies of final inspection certificates.
- B. Include:
 1. Letters from the AVSC and all AV Subcontractors, on their respective letterheads, certifying that the AV systems are substantially complete, fully tested and adjusted, fully operational, and ready for inspection, final testing, and tuning.
 2. Preliminary audiovisual systems commissioning checklist.
 3. Digital photographs of the completed installation. Include photographs of:
 - a. An elevation view of the front wall of each room equipped with projection screen(s), showing the screen, loudspeakers, and other system elements.
 - b. A view of each equipment room, showing the equipment racks, backboards, terminal cabinets, and other installed materials.
 - c. An elevation view of each equipment rack cabinet taken with the front door (if any) fully open, and a view of the interior of each equipment rack cabinet.
 - d. A view of each type of wall-mounted device, including cameras, monitors, control panels, etc.
 - e. A view of each type of ceiling-mounted device, including loudspeakers, etc.
 - f. Close-up views of each type of input panel and output panel.
 - g. Close-up views of each type of floor box/pocket with the covers open, and with the covers closed.
 - h. Professional photographs are not required; color snapshots with minimum size of 3" x 5" is acceptable. Photographs shall be legible, well lighted, and well-focused, and composed to fill the image with the intended subject as much as possible.
 4. List of discrepancies and corrective action taken.
- C. Acceptance Testing
 1. The Engineer will schedule a site visit once the AVSC's Completion Report has been submitted and approved. Allow at least 10 calendar days between receipt of Completion Report by Engineer and the earliest desired date for the site visit by Engineer. The AVSC is encouraged to communicate informally with the Engineer prior to submission of Completion Report to coordinate the scheduling of the Engineer's site visit.
 2. The AVSC will assist the Engineer in performing acceptance tests, equalization, and other system adjustments.
 3. The AVSC will assist the Engineer in making final tests, equalization, and other adjustments. This shall include listening and viewing tests, including subjective tests by observers and various positions, under various operating conditions.
 4. All final, as-built drawings, run sheets, manuals, and other required documents shall be on hand.
 5. Manuals: All manufacturers' maintenance, service, and alignment manuals shall be present during testing and adjustment procedures.
 6. System Acceptance Tests will be supervised by the Engineer and will consist of the following:
 - a. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents.
 - b. The operation of all system equipment shall be demonstrated by the AVSC.

- c. The operation of the control systems/touch panels will be reviewed for acceptance by the Owner.
 - d. Listening and viewing tests, including subjective tests by observers at various positions, under various operating conditions.
 - e. A random verification of measurements submitted with the audiovisual systems commissioning checklist.
 - f. Final adjustments to signal processors and system gain settings.
7. The Contractor shall provide on-site personnel who performed the installation and testing.
 8. Contractor shall make any adjustments, including but not limited to re-wiring of speaker taps, resetting of gain controls, changes in shielding or grounding, and minor changes in wiring and termination, which are deemed necessary by the Engineer. Such work shall be included in the base bid contract amount.
 9. Make any adjustments, including but not limited to re-wiring of speaker taps, resetting of gain controls, changes in shielding or grounding, and minor changes in wiring and termination, which are deemed necessary by the Engineer. Such work shall be included in the base bid contract amount.
- D. Additional Site Visits
1. Additional site visits may be deemed necessary by the or AV Consultant if any of the following conditions are found during the initial acceptance testing site visit:
 - a. Items of equipment which are missing or non-operational.
 - b. Items of equipment which do not meet the specifications, or the manufacturers published performance criteria.
 - c. Hum, buzz, or noise which degrades the signal to noise ratio of any circuit by more than 5 decibels from the manufacturers' rated signal-to-noise ratios for the upstream components.
 - d. Audio distortion which is audible or video distortion which is visible.
 - e. Any other conditions which are not in accordance with the specifications, drawings, AV Systems Contractor's submittals, Completion Report, or audiovisual systems commissioning checklist.
 2. In the event further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the Engineer.
 3. The AVSC shall make every possible effort to correct the deficiencies during the site visit to avoid additional site visits.
 4. The AVSC will render reasonable assistance to avoid additional site visits, including extending the site visit, so long as it does not hamper other work of the site visit.
 5. Any charge for additional time incurred by the Consultant required to observe system tests due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to, the AVSC.
 6. If additional site visits are deemed necessary, the Owner will submit a written notification of the reasons with descriptions of the deficiencies to be corrected.
 7. If additional site visits are deemed necessary:
 - a. The Consultant will submit a written notification of the reasons with descriptions of the deficiencies to be corrected.
 - b. Under this Section, with no increase in the Contract amount, the AVSC shall pay for the additional site visits by the Consultant, in the form of reimbursement to the Owner or Architect for their actual cost of services by AEI NW. AEI NW will bill the additional services for the additional site visit(s) at its prevailing standard hourly rates for time (including travel time), plus actual costs for travel per diem, and related expenses.

3.010 CLEANING

- A. Leave installations clean and premises free from residue and debris from work of this Section.

B. Waste Management:

1. AVSC shall continually remove debris, cuttings, crates, cartons, etc., created by his work. Perform clean up daily to eliminate hazard to the public, other workmen, the building or the Owner's employees. Before acceptance of the installation, AVSC shall carefully clean cabinets, panels, lighting fixtures, wiring devices, cover plates, etc., to remove dirt, cuttings, paint, plaster, mortar, concrete, etc. Blemishes to finished surfaces of apparatus shall be removed and new finish equal to the original applied.
2. Remove dirt and debris from the interior of enclosures, outlet boxes, pull and junction boxes, and equipment cabinets.
3. Clean equipment to remove plaster, taping or patching compound, overspray, paint spills, oil, grease, dust, fingerprints, or other dirt or contaminants to restore equipment to original finish and condition.

3.011 CLOSEOUT ACTIVITIES

A. Demonstration

1. After substantial completion of the work and after all tests and final inspection of the work by the AV Consultant, the Contractor shall demonstrate the systems and instruct the Owner's designated operating and maintenance personnel in their operation and maintenance. The Contractor shall arrange scheduled instruction periods with the Owner. The Contractor's representatives shall be superintendents or foremen knowledgeable in each system, and suppliers' representatives when so specified.

B. Training

1. At the completion of installation, submit a written request to the Owner to schedule the training sessions, at least two weeks in advance of the requested dates.
2. At a minimum, provide the following sessions of training for systems users, covering operations. Each session shall be for at least the specified number of hours and number of attendees per session.
 - a. General Operations: at least one session for operations and management staff.
 - b. Technical Operations: at least two sessions for AV technical staff, covering detailed operations and maintenance.
3. At least one of each type of class (as selected by Owner's representative) shall be videotaped by the contractor, with copies of tapes turned over to the Owner's representative as part of the O&M manuals.
4. All maintenance and operational aspects of the systems shall be described and demonstrated to personnel selected by the Owner. The sessions shall be conducted by a representative thoroughly familiar with the characteristics of the system. O&M manual information regarding the system shall be submitted to the Owner prior to scheduling the instruction session. The training session should cover the following areas:
 - a. General operation of all systems and functions.
 - b. Explanation and orientation of all technical documentation.
 - c. Explanation of signal flow including all signal paths through routing switchers and patching.
 - d. Basic system troubleshooting and preventive maintenance.
 - e. Explanation of system warranty and process for owner to follow during system malfunctions to obtain customer support from the AVSC.

3.012 ATTACHMENTS

A. Schedules

1. Section 27 41 00.1 – Audiovisual Systems Equipment Schedule
2. Section 27 41 00.2 – Audiovisual Systems Cable Schedule
3. Section 27 41 00.3 - Audiovisual Systems Commissioning Checklist

END OF SECTION

ROOM NAME	PROJECTION SYSTEMS	VIDEO SYSTEMS	AUDIO SYSTEMS	CONTROL & MISC. SYSTEMS	TOTAL EQUIPMENT COSTS	NON-EQUIPMENT LABOR COSTS	TOTAL AV CONTRACTOR COSTS	BASE BUILDING COSTS	ROOM AV COSTS	QTY	TOTAL BY ROOM
Room 1	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -
Room 2	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -
Room 3	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -
Room 4	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -
Room 5	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -

SUBTOTAL: \$ -
 CONTINGENCY: 15% \$ -
 TOTAL: \$ -

NOTES:

This budget recommendation is our opinion of the probable cost of construction for a qualified audiovisual systems integrator to provide and install the systems described in our report. Equipment and material prices are taken from the manufacturer's suggested retail price information; labor and installation is estimated as a percentage of the equipment and material pricing.

All pricing is Y2015 dollars and includes equipment, labor, installation materials (such as wire and cable), and overhead and profit for the systems integrator. Pricing does not include overhead and profit for contractors tiered above the audiovisual systems integrator, such as a general contractor, and do not include taxes. This budget also does not include costs for electrical raceway (conduit, boxes, etc.) that are expected to be included in the general electrical work.

Because the audiovisual systems design has not been completed, this information is preliminary, and should be considered a budgetary recommendation rather than a construction cost estimate. The actual construction cost could change as the design evolves, and could vary due to bidding and market conditions.

Eqpt. ID	Mfg.	Model #	Description	QTY	Notes
DISPLAY/PROJECTION					
VP/1	NEC	NP-P424W	VIDEO PROJECTOR	1	
	CHIEF	RSMAU	PROJECTOR MOUNT	1	
	CHIEF	CMS006009	ADJUSTABLE EXTENSION	1	
	PEERLESS	ACC640	ESCUTCHEON RING	1	
	AVSC	CUSTOM	MOUNTING HARDWARE	1	
	SONIC SHOCK	SONIC SHOCK 5	SECURITY ALARM	1	
	DA-LITE	MODEL C	16;10, MATTE WHITE, 109" PROJECTION SCREEN	1	PROVIDE W/MOUNTING BRACKET
VIDEO					
DOC/1	LUMENS	DC-193	DOCUMENT CAMERA	1	
AVS/1	CRESTRON	DMPS3-400K-100-C	AV SWITCHER/CONTROL	1	
AUDIO					
AMP/1	CRESTRON	MP-AMP30	POWER AMPLIFIER	1	
S1	ATLAS	FAP40T	LOUDSPEAKERS		QTY NOTED ON PLANS
PC/1	HP		DESKTOP PC	1	FBOIC
MON/1	HP		23" PC MONITOR	1	FBOIC
DVD/1	VARIOUS		DVD/VCR PLAYER	1	FBOIC
CONTROL/MISC					
CP/1	CRESTRON	TSW-560-B-S	CONTROL INTERFACE	1	
	CRESTRON	TSW=560-TTK-B-S	TABLE MOUNT	1	
	CRESTRON	CBL-HD-6	HDMI Cabling for desk laptop	1	
	CRESTRON	CBL-VGA-AUD-6	VGA Cabling for desk laptop	1	
	CRESTRON		Displayport to HDMI 6' for desk pc	1	
	COMPREHENSIVE	VGA15P-5BJ-6INHR	VGA to 5 BNC 6ft for DVD/VCR	1	
	EXTRON		BNC Male to RCA Male Coupler Adapter	1	
	EXTRON		3.5mm Male to RCA L/R Male Adapter Cable	1	
	EXTRON		Audio Cable 6' 3.5mm M-M	1	
	CRESTRON	DM-CBL-8G-P	Crestron DM-CBL-8G-P 500' spool DM cabling		QTY. AS NEEDED
	CRESTRON	DM-8G-CONN-WG	Crestron DM-8G-CONN-WG RJ-45 Connector	4	
	C2G	CAT6e PATCH CABLE	3' network cable, Black	2	
			Shielded Cat6 Keystone Coupler Insert	1	
	TECH FLEX		30' CABLE SLEEVE	1	
	APC	SURGEARREST P8U2	POWER DISTRIBUTION UNIT	1	
	DECORA		WALL PLATE	1	VERIFY SIZE W/OWNER
AVNS/1	CRESTRON	CEN-SW-POE-5	NETWORK SWITCH	1	

Eqpt. ID	Mfg.	Model #	Description	QTY	COST/ITEM	EXTENSION	RUs
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Eqpt. ID	Mfg.	Model #	Description	QTY	COST/ITEM	EXTENSION	RUs
DISPLAY/PROJECTION							
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SUB TOTAL						\$ -	
VIDEO							
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SUB TOTAL						\$ -	
AUDIO							
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SUB TOTAL						\$ -	

Eqpt. ID	Mfg.	Model #	Description	QTY	COST/ITEM	EXTENSION	RUs
CONTROL/MISC							
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			SUB TOTAL			\$ -	
BASEBUILDING AV							
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Exten.	Draw	Exten.	Btu/hour	Exten.	lbs	Exten.	Notes
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Projection Systems (BTU/hr)	Projection Systems (CFM)	Video Systems (BTU/hr)	Video Systems (CFM)	Audio Systems (BTU/hr)	Audio Systems (CFM)	Control Systems (BTU/hr)	Control Systems (CFM)	Total (BTU/hr)
BTU/hr	CFM	BTU/hr	CFM	BTU/hr	CFM	BTU/hr	CFM	BTU/hr
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Total (CFM)
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SIGNAL	DESCRIPTION	MFG.	NON-PLENUM	Rating	Diameter		PLENUM	Rating	Diameter		MATING CONNECTORS			
Audio				NEC	(Inch)	(mm)		NEC	(Inch)	(mm)	Balanced	Unbalanced	BNC	F-Conn
Balanced or Unbalanced	2C#22, STP	BELDEN	9451	CMR	0.135		9451P	CMP	0.127		NC3FX, NC3MX, NP3X-BAG	NP2X-BAG, NF2C-B/2		
Balanced or Unbalanced	2C#22, STP, Stereo Pair	BELDEN	9451D	CMR	0.135		9451DP	CMP	0.127		NC3FX, NC3MX, NP3X-BAG	NP2X-BAG, NF2C-B/2		
Loudspeaker	2C#18	BELDEN	5300UE	CMR	0.158		6300UE	CMP	0.154					
Loudspeaker	2C#16	BELDEN	5200UE	CMR	0.180		6200UE	CMP	0.176					
Loudspeaker	2C#14	BELDEN	5100UE	CL3R	0.218		6100UE	CL2P	0.218					
Loudspeaker	2C#12	BELDEN	5000UE	CL3R	0.260		6000UE	CL2P	0.252					
Loudspeaker	2C#10	BELDEN	5T00UP	CL3	0.356		6T00UP	CL3P	0.308					
Video														
Analog/SDI	Miniature RG/59U	BELDEN	1855A	CM	0.159		1855P	CMP	0.159					1855ABHDL
Analog/SDI	Miniature 5C RG/59U Snake	BELDEN	7789A	CMR	0.539									1855ABHDL
Analog/SDI	RG/59U	BELDEN	1505A	CM	0.233		1506A	CMP	0.196					1505ABHDL, 1506ABHDL
Analog/SDI	5C RG/59U Snake	BELDEN	7796A	CM	0.790									1505ABHDL
Analog/SDI	RG/6U	BELDEN	1694A	CM	0.274		1695A	CMP	0.235					1694ABHDL, 1695ABHDL
Analog/SDI	5C RG/6U Snake	BELDEN	7712A	CM	0.970									1694ABHDL
Analog/SDI	RG/11U	BELDEN	7731A	CMR	0.400		7732A	CMP	0.348					FS11BNC
CAT 5e	24 AWG, SOLID, 4-PR BONDED UTP	BELDEN	1700A	CMR	0.166		1701A	CMP	0.195		100 011LW			
CAT 6	23 AWG, SOLID, 4-PR BONDED UTP	BELDEN	1872A	CMR	0.365		1874A	CMP	0.365		100 011LW			
Low Skew Cable	23 AWG 4 Pair UTP Low Skew Video Cable	BELDEN	7988R	CMR	0.204		7988P	CMP	0.193		301602			
Low Skew Cable	23 AWG 4 Pair UTP Low Skew Video Cable	EXTRON	22-141-03	CMR	0.280		22-142-03	CMP	0.240		100 011LW			
DBS/Satellite	RG-6 18AWG Solid BC Dual Shield	BELDEN	1829AC	CATV, CM	0.270									DB6U
CATV	RG-6 18AWG Solid Dual Shield	BELDEN	9116	CATV, CM	0.270		9116P	CATVP, CMP	0.235					DB6U, DB6PL2
CATV	RG-6 18AWG Solid CCS Quad Shield, 3.0GHz	BELDEN	1189A	CM	0.294		1189AP	CATVP, CMP	0.248					DB6U, DB6PL2
CATV	RG-11 14AWG Solid CCS Dual Shield	BELDEN	1523A	CATV, CM	0.393		1523AP	CATVP, CMP	0.348					FS11V, FS11PL
HDMI	28 AWG, 4-PR/28 AWG, 1-PR/28 AWG, 5C	COVID	HD-280RD	CMR	0.260		P-HD-28	CMP	0.280	7.00				
Multimedia														
HDBaseT - AMX	23AWG Solid, 4 Pair, F/UTP, Non-bonded	BELDEN	10GX62F	CMR	0.295		10GX63F	CMP	0.295					
	23AWG Solid, 4 Pair, F/UTP	GEPCO	CT104/SDM-07	CMR	0.310		CT104/SDMP-07	CMP	0.295					
HDBaseT - Crestron	24AWG Solid, 4 pair, F/UTP	CRESTRON	DM-CBL-8G-NP	CM	0.244		DM-CBL-8G-P	CMP	0.244					
	23AWG Solid, 4 Pair, F/UTP, Non-bonded	BELDEN	10GX62F	CMR	0.295		10GX63F	CMP	0.295					
	23AWG Solid, 4 Pair, F/UTP	GEPCO	CT104/SDM-07	CMR	0.310		CT104/SDMP-07	CMP	0.295					
HDBaset - Extron	26AWG Solid, 4 Pair, S/FTP	EXTRON	22-214-03	CMR	0.250		22-215-03	CMP	0.235					STP RJ-45
RF/Wireless														
50-OHM COAX	RG/58U	BELDEN	8240	CMX	0.193		82240	CMP	0.159					
Control														
DMX Control	24 AWG 2 Pair twisted double shielded low capacitance 120Ω	BELDEN	9842	CM	0.340		82842	CMP	0.273					NC5MX, NC5FX
AXLink/CresNet	Ultralow Capacitance 105Ω twisted shielded pair with 18/2 power	BELDEN	1502R	CMR	0.250		1502P	CMP	0.205					
RS-232/485	22AWG SHIELDED TWISTED PAIR	BELDEN	8723	CM	0.160		88723	CMP	0.148					DB9M, DB9F
RELAY	4C#20 UNSHIELDED	BELDEN	5402UE	CMR	0.160		6402UE	CMP	0.156					
DATA														
CAT 5e	24 AWG, SOLID, 4-PR UTP	BELDEN	1583A	CMR	0.190		1585A	CMP	0.190					
CAT 6	23 AWG, SOLID, 4-PR U/UTP	BELDEN	2412	CMR	0.225		2413	CMP	0.230					
Fiber														
Riser Single Mode	* = Fiber count, Suffix D = Distribution, BO = Breakout, many styles		*FRIOSM-	OFNR	Varies		*FRIOSM-	OFNR	Varies					95-200 series
Riser 62.5/125 Style	* = Fiber count, Suffix D = Distribution, BO = Breakout, many styles		*FRIOMM6-	OFNR	Varies		*FRIOMM6-	OFNR	Varies					95-000 series
Riser 50/125 Style	* = Fiber count, Suffix D = Distribution, BO = Breakout, many styles		*FRIOMM5-	OFNR	Varies		*FRIOMM5-	OFNR	Varies					95-050 series

SIGNAL	DESCRIPTION	MFG.	NON-PLENUM	Rating	Diameter	PLENUM	Rating	Diameter	MATING CONNECTORS	
DC Power										
Remote Power Supply	22 AWG, 2 Conductor twisted unshielded general purpose	LIBERTY	22-2C-GRY	CMR	0.120	22-2C-P-GRY	CMP	0.118		
Remote Power Supply	18 AWG, 2 Conductor twisted unshielded general purpose	LIBERTY	18-2C-GRY	CMR	0.166	18-2C-P-GRY	CMP	0.154		
Specialty										
Projector Application	26 AWG stranded 6 Coaxial plus 2 pair control Jacketed		RGB6C/22-2P	CL2	0.410	10.41	RGB6C/22-2P	CL2	0.410	10.41
Retrofit Applications	20 AWG Solid 6 Coaxial+ 2 Cat5e UTP Jacketed		RGB6C-20/2L5E	CMR	0.960	24.38	RGB6C-20/2L5E	CMR	0.960	24.38
Retrofit Applications	23 AWG Solid 6 Coaxial+ 2 Cat5e UTP Jacketed		RGB6C-23-2L5E	CMG	0.627	15.93	RGB6C-23-2L5E	CMG	0.627	15.93
Retrofit Applications	25 AWG Solid 6 Coaxial+ 2 Cat5e UTP Jacketed		RGB6C-25-2L5E	CM	0.533	13.54	RGB6C-25-2L5E	CM	0.533	13.54
Rack Interconnection	Mini RG59/U 23 AWG High Definition Serial Digital Coaxial Cable		23-MINI-SD	CM	0.164	4.17	23-MINI-SD	CM	0.164	4.17
Microphone	24 AWG 2 Pair Star Quad style extra flexible Mic cable		24-2P-STAR-BLK	CM	0.240	6.10	24-2P-STAR-BLK	CM	0.240	6.10
									NC3FX, NC3MX	

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
Audio System Performance Reference Verification Items						
AP-100	Emergency Muting	Verify that any required muting or operational change of the installed sound system(s) has been made in accordance with local regulations in the event of a life safety or similar emergency.	X	X	X	
AP-101	Loudspeaker Zoning	Verify that loudspeaker zones are wired as defined in the project documentation.	X	X		
AP-102	Alignment of Multiple Audio Source Levels	Alignment of calibration of permanent audio system inputs such that the difference between any input signal level after the first common gain adjustment meets the requirements of the project documentation.		X	X	
AP-103	Audio Buzz and Rattles	Verify that no audible noise caused by improper installation of any equipment provided in completed system(s) is present.		X	X	
AP-104	Audio Routes	Verify that all audio routes are tested from endpoint to endpoint via the appropriate midpoint(s) for operation and routing as defined in the project documentation.		X	X	
AP-105	AV Room Reverberation Time	Verify reverberation time meets the requirement defined in the project documentation.			X	
AP-106	DSP Programming	Verify that all DSP-based products have been programmed as defined in the project documentation.		X	X	
AP-107	Loudspeaker Physical Alignment	Verify that loudspeakers are placed and aimed as defined in the project documentation.		X	X	
AP-108	Loudspeaker Polarity	Verify that all loudspeakers have correct polarity as defined in the project documentation.		X	X	
AP-109	Loudspeaker Time Alignment	Verify that loudspeaker time alignment performs as defined in the project documentation.		X	X	
AP-110	Phantom Power	Verify that power is provided at the correct voltage and correct locations as defined in the project documentation.		X	X	
AP-111	Loudspeaker Transformer Tap Setting	Verify the loudspeaker transformer tap setting in constant voltage systems is as defined in the project documentation.		X		
AP-112	Acoustical Ambient Noise	Verify that the background acoustic noise levels within audiovisual spaces are within the required limits as detailed in the project documentation. This test is specifically related to ambient noise levels and not audio system electronic quiescent noise, which is tested separately.			X	
AP-113	Assistive Listening Devices	Verify that all devices that are part of the assistive listening system have been tested as a complete end-to-end personal listening system. Verify that the assistive listening system complies with regulatory requirements and adheres to project documentation.			X	

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
AP-114	Audio Coverage in Listener Area	Verify that the coverage of the audio systems in listener areas meets the performance requirements as defined in the project documentation. ANSI/INFOCOMM A102.01.2017, Audio Coverage Uniformity in Listener Areas should be used. Perform separate tests for all independent systems within the project, including but not limited to program sound, speech reinforcement, and show relay.			X	
AP-115	Audio Dynamics	Verify use of audio dynamics, including but not limited to noise compensation, automatic gain control, gating, feedback suppression, compression, limiting, delays, and levelers, meets the requirements defined in the project documentation.			X	
AP-116	Audio Level Exceeds Background Noise Level	Verify that the audio level provided by the installed audio system exceeds the background noise level as defined in the project documentation.			X	
AP-117	System Electronic Frequency Response	Verify that the electronic frequency response of the audio system is as defined in the project documentation.			X	
AP-118	Audio System Equalization for Spectral Balance	Verify that the audio system equalization is in accordance with the acoustic response curves as defined in the project documentation.			X	
AP-119	Audio System Latency	Verify that audio system latency meets requirements defined in the project documentation.			X	
AP-120	Audio System Speech Reproduction at Listener Positions	Verify that the audio system provides speech reproduction (intelligibility) as defined in the project documentation.			X	
AP-121	Audio System Total Harmonic Distortion	Verify that the total harmonic distortion of the installed audio system is as defined in the project documentation.			X	
AP-122	Conferencing Audio Far-Side Level Adjust	Verify that in a conferencing audio application, the incoming and outgoing audio levels are checked and adjusted in the system as defined in the project documentation.			X	
AP-123	Conferencing Echo Suppression Performance	Verify that a system with conferencing capability performs at nominal operating levels in a full duplex mode with echo and latency performance as defined in the project documentation.			X	
AP-124	Loudspeaker Impedance	Verify that all loudspeaker circuits have the correct impedance as defined in the project documentation.			X	
AP-125	Microphone Physical Alignment and Placement	Verify proper alignment and placement of microphones in the system as defined in the project documentation.			X	
AP-126	Microphone Gain Before Feedback	Verify that the speech reinforcement system is operating without feedback and at audio levels as defined in the project documentation.			X	

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
AP-127	Microphone Level Alignment	Verify calibration of microphone inputs so that the difference between any input signal level after the first common gain adjustment meets the requirements of the project documentation.			X	
AP-128	Multi-Channel Loudspeaker System Output	Verify that the audio outputs of a multi-channel loudspeaker system are assigned correctly to designated outputs as defined in the project documentation.			X	
AP-129	Sound Masking	Verify that audio system sound-pressure levels and equalization are adjusted to the level of sound masking as defined in the project documentation.			X	
AP-130	Audio Reinforcement System Headroom	Verify that the audio system is capable of performing above nominal operating levels without distortion as defined in the project documentation.			X	
AP-131	Audio System Signal-to-Noise Ratio	Verify audio system electrical signal-to-noise ratio meets the minimum levels defined in the project documentation.			X	

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
Video System Performance Verification Items						
VP-100	EDID Management Plan	Verify that the EDID (Extended Display Identification Data) management plan has been implemented as defined in the project documentation.	X	X		
VP-101	HDCP Management Plan	Verify that the HDCP (High-bandwidth Digital Content Protection) management plan has been implemented as defined in the project documentation.	X	X		
VP-102	Projected Display Physical Alignment	Verify that the combined installation of projector and screen provides a displayed image that is correctly aligned to the active projection screen surface without misalignment unless an alternative condition is specified in the project documentation.		X	X	
VP-103	Video System Pixel Failure Tolerance	Verify that all display images do not have pixel failures (bright or dead pixels) that exceed the requirements of the project documentation or the manufacturer's specifications.		X	X	
VP-104	Image Geometry	Verify that all displayed images are correctly focused, have the correct image geometry and are free from distortion (e.g., stretching, keystone, barrel/pincushion). Any requirements for projection mapping or image shaping to unusual surfaces should be validated in accordance with the requirements of the project documentation.		X		
VP-105	Displayed Image Performance	Verify that the components of the displayed image system(s) (projection or direct-view) perform(s) as required with relation to image size, viewing angles, sight lines, viewer locations, and/or any other requirements as defined in the project documentation.	X	X	X	
VP-106	Colorimetry	Verify calibration of all video displays to ensure they display colors uniformly to a common reference standard as defined in the project documentation.			X	
VP-107	Multiple Resolution Performance of Video Displays	Verify that the system(s) accurately display(s) all resolutions required by project documentation on all displays within the system (i.e., no pixel shift, no geometric distortion, no artifacts from scaling, letterboxing, pill-boxing, or window-boxing).			X	
VP-108	Projected Display Brightness Uniformity	Verify that the combined installation of projector and screen provides a display to the viewer that meets the requirements of the project documentation.			X	
VP-109	Projected Image Contrast Ratio	Verify that the system conforms to the appropriate viewing category as defined in the project documentation. The testing methodology in ANSI/INFOCOMM 3M-2011 shall be used. The projected image contrast ratio shall be measured for all projected images within the system.			X	

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
VP-110	Test Video Routes	Verify that all video routes are tested from endpoint to endpoint via the appropriate midpoint(s) for operation and routing required by the project documentation.			X	
VP-111	Video Camera Image and Operation	Verify that cameras, lenses, and pan/tilt systems operate as defined in the project documentation. Inspect the camera image through the full lens operation.			X	

Audio/Video System Performance Verification Items

AVP-100	Emergency Communications	Verify that emergency communications systems properly receive inputs and information from other systems (including but not limited to life safety systems, security systems, and weather notifications) and deliver appropriate notifications to target audiences, comply with regulatory requirements, and adhere to requirements defined in the project documentation.		X	X	
AVP-101	Genlocking (Video Synchronization)	Verify that the video synchronization of the system is performing as defined in the project documentation.		X	X	
AVP-102	Audio and Video Recording	Verify that audio and video signals are being routed to the recording device(s) and that the recording device(s) is or are operating correctly, as defined in the project documentation.			X	
AVP-103	Audio/Video Recording	Verify that audio/video synchronization is maintained to ensure the proper time alignment of signals during playback at the point of user experience or transmission as defined in the project documentation.			X	
AVP-104	Radio Frequency Television Distribution	Verify that the radio frequency and satellite intermediate frequency distribution systems provide all services to all endpoints as defined in the project documentation.			X	
AVP-105	Source Testing	Verify that the signal produced by a source typical of what will be used in normal operation of the system is routed through the system to applicable endpoints and produces the performance as defined in the project documentation.			X	

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
Cable Management, Termination, and Labeling Reference Verification Items						
CABL-100	Cable Bend Radius	Verify that cables are not bent beyond their minimum bend radius as specified in cable data sheet in order to maintain signal integrity as defined in the project documentation. Project documentation may state a larger radius to allow for a safety margin.	X	X		
CABL-101	AV Connector Plate Input and Output Labeling	Verify that all AV connector plate inputs and outputs are labeled as defined in the project documentation.		X		
CABL-102	AV Connector Seating	Verify that all AV connectors are correctly keyed, seated, and latched to respective connection points as defined in the project documentation. Conditions where physical parameters exceed the connector's ability to maintain full seating should be resolved as defined in the project documentation.		X		
CABL-103	AV Connector Verification	Verify that all AV cable terminations are made securely and meet the recommendations of the connector and cable manufacturer(s), published standards, and requirements defined in the project documentation.		X		
CABL-104	AV Equipment Power Cable Management	Verify that all AV equipment power cables are managed as defined in the project documentation. Verify that cables are managed in a uniform and acceptable manner so as not to compromise safety/OEM warranty, AV signal quality, and/or future field service.		X		
CABL-105	AV System Cable Labeling	Verify that all AV system cables are identified by a unique ID as defined in the project documentation. Verify that this unique ID is displayed permanently at both ends of the cable, is legible, and is positioned where it can be seen without undue disturbance.		X		
CABL-106	Cable Separation	Verify that both site and rack cables have appropriate separation according to signal type and level as defined in the project documentation.		X		
CABL-107	Cable Supports	Verify that all cables are supported throughout their lengths as defined in the project documentation.		X		
CABL-108	Cable Ties	Verify that, where appropriate, cable ties are used to secure the cables, are correctly tensioned, and that the correct type of cable tie(s) is used as defined in the project documentation.		X		
CABL-109	Cables Bundled by Type	Verify that cables are only bundled together when their construction, signal type, and signal level are compatible and will not cause measurable crosstalk or interference between cables.		X		
CABL-110	Cables Dressed	Verify that cables are dressed to ensure that all rack and site cables are installed to provide serviceability, safety, and aesthetics as defined in the project documentation.		X		
CABL-111	Patch Panel Configuration	Verify that all patch panels have been correctly wired and configured as defined in the project documentation		X		

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
CABL-112	Patch Panel Labeling	Verify that all patch panels have been labeled as defined in the project documentation. Verify that all labeling is machine-printed, consistent, durable, accurate, and legible.		X		
CABL-113	Termination Stress	Verify that all cable terminations have been completed and adequately supported to minimize stress on the termination point and/or connector.		X		
CABL-114	AV Connector Plate Consistent Labeling	Verify that AV connector plates have consistent labeling throughout the project as defined in the project documentation.			X	
CABL-115	AV System Cabling Verification	Verify that all cabling is the correct type and routed correctly from point to point as defined in the project documentation.			X	
CABL-116	Cable Length Required for Serviceability	Verify that sufficient cabling is available so the device can be placed in a serviceable location as defined in the project documentation.			X	

Control Reference Verification Items

CON-100	Control System Communications	Verify that all control communications are tested from endpoint to endpoint via the appropriate midpoint(s) for operation and functionality as defined in the project documentation.		X	X	
CON-101	Interfacing and Control of External Devices and Systems	Verify that AV control system interfaces to and from control systems provided by others conform to requirements as defined in the project documentation.		X	X	
CON-102	Mobile Device Integration	Verify that mobile devices that are to be supported are integrated and operating as defined in the project documentation.		X	X	
CON-103	System Response to Emergency Condition	Verify that any required response of the installed audiovisual system(s) in the event of a life safety or similar emergency operates in accordance with local regulations and as defined in the project documentation. This item specifically excludes sound system response to an emergency condition, which is covered under item AP-100, Emergency Muting.		X	X	
CON-104	Control System Automated Functions	Verify that all time-dependent or automated functions executed by the control system conform to requirements as defined in project documentation.			X	
CON-105	Control System User Interface Performance	Verify that the control system is implemented in a manner consistent with the requirements as defined in the project documentation.			X	
CON-106	Control System Response Time	Verify that the control system provides the user response time and maximum latency defined in the project documentation.			X	

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
System and Record Documentation Reference Verification Items						
DOC-100	Final Inventory of AV Equipment	Verify that all equipment has been delivered as defined in the project documentation.	X	X	X	
DOC-101	Approval of Samples	Verify that samples of all equipment to be used as defined in the project documentation have been submitted for approval.	X			
DOC-102	Delivered Product Against Samples	Where samples of products have been required for approval, verify that the products that are delivered are the same and of the same quality.		X		
DOC-103	Wireless Frequency Licensing	Verify that the correct and valid wireless frequency licensing permits have been obtained for legal operation of the system.		X		
DOC-104	Consultant's Testing	Verify that any consultant's testing requirements defined in the project documentation have been performed and approved.			X	
DOC-105	General Contractor's Testing	Verify that any general contractor's testing requirements defined in the project documentation have been performed and approved.			X	
DOC-106	Integrator's Testing	Verify that any integrator's testing requirements have been performed and approved as defined in the project documentation.			X	
DOC-107	Manufacturer's Testing	Verify that any manufacturer's testing requirements defined in the project documentation have been performed and approved.			X	
DOC-108	Owner's Testing	Verify that any owner's testing requirements defined in the project documentation have been performed and approved.			X	
DOC-109	Third-Party Testing	Verify that any third-party testing requirements have been performed and approved as defined in the project documentation.			X	
DOC-110	Substantial/Practical Completion	Verify that a conditional acceptance of the project has been issued by the owner or owner's representative, acknowledging that the project or a designated portion is substantially/practically complete and ready for use by the owner, however some requirements and/or deliverables defined in the project documentation may not be complete.			X	
DOC-111	As-Built Drawings Complete	Verify that a complete set of accurate as-built drawings indicating all AV devices, AV device locations, mounting details, system wiring and cabling interconnects, and all other details has been provided as defined in the project documentation.				X
DOC-112	Audio System Test Reporting	Verify that the audio system test report has been completed and issued as defined in the project documentation.				X

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
DOC-113	Control System Test Reporting	Verify that the control system test report has been completed and issued as defined in the project documentation.				X
DOC-114	Final Commissioning Report and System Turnover	Verify that the final commissioning report has been completed, issued to the proper entity, and accepted as defined in the project documentation.				X
DOC-115	Required Closeout Documentation	Verify that a complete set of as-built system documentation has been provided as defined in the project documentation.				X
DOC-116	Software Licensing	Verify that the usage and ownership rights have been assigned as defined in the project documentation.				X
DOC-117	User Manuals	Verify that manufacturer's user manuals are delivered to the owner in a format defined in the project documentation (e.g., binders, PDFs), or dispose of the manuals in a responsible manner (recycling) if the owner specifies that they do not wish to receive the manuals. Integrator- or programmer-created manuals and documentation shall be delivered to the owner in a format defined in the project documentation.				X
DOC-118	Video System Test Reporting	Verify that the video system test report has been completed and issued as defined in the project documentation.				X
DOC-119	Warranties	Verify that all warranties are activated and that all warranty details have been passed to the owner as defined in the project documentation.				X
DOC-120	Final Acceptance	Verify that a final acceptance of the project has been issued by the owner or owner's representative, acknowledging that the project is 100% complete, that all required deliverables, services, project-specific verification lists, testing, verification and signoffs have been received, and that all requirements defined in the project documentation have been satisfied and completed.				X

Electrical Reference Verification Items

ELEC-100	AV Equipment Connected to Proper Circuit	Verify that all AV equipment is powered from the designated power circuit and outlet as defined in the project documentation. No additional (non-AV) equipment should be connected unless permitted in the project documentation.	X	X	X	
ELEC-101	Grounding/Earthing	Verify that all elements of the AV system are correctly bonded to an electrical ground/earth in accordance with the requirements of the regulatory authority and as defined in the project documentation.	X	X		

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
ELEC-102	Mains Voltage Sub-Distribution Integrity	Verify that all electrical sub-distribution systems provided by the AV contractor in equipment racks, furniture, and similar structures meet local regulatory requirements for electrical integrity.	X			
ELEC-103	Power Sources	Verify that the sources of mains voltage AC power to be used for the supply of AV equipment are correct as defined in the project documentation and have been tested to the outlet in accordance with local electrical standards.	X			
ELEC-104	Power Sequencing	Verify that the power sequencing of devices is correct as defined in the project documentation.		X	X	
ELEC-105	UPS Operation	Verify that the uninterruptible power supply (UPS) is performing to the specifications as defined in the project documentation.		X	X	
ELEC-106	DC Power Distribution	Verify that all DC powered devices are receiving the proper voltage and current for normal operation.		X		
ELEC-107	Power Loss Recovery	Verify that the AV systems resume normal operation on the restoration of power following a hard electrical power outage. Power loss recovery shall include verification of the resumption state on power recovery. Resumption state shall be the control system start-up condition/start page (where applicable) and resetting all devices to a known state as defined in the project documentation.			X	
ELEC-108	Power Monitoring	Verify power-monitoring equipment is working and reporting as defined in the project documentation. Power-monitoring equipment should be verified with a known electrical load where possible. If power-monitoring data is being collected for an energy management system, connectivity with the system should be verified.			X	

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
Information Technology Verification Items						
IT-100	Content Delivery Network	Verify that the content delivery network (e.g., digital signage) is in place and provides the required connectivity for the required audio, video, and control systems. Verify that all required content licensing has been acquired.	X	X	X	
IT-101	IEEE 802 Wireless Security	Verify that the wireless network is protected in accordance with the client/owner's information security policies from unauthorized access and provides the required connectivity for the audio, video, and control systems.	X	X	X	
IT-102	Network Bandwidth	Verify that the required network bandwidth is available for control, audio, video, and data as part of either a shared or a dedicated audiovisual network.	X	X	X	
IT-103	Network QoS (Quality of Service)	Verify that the required Quality of Service (QoS) is in place for audio, video, and data as part of either a shared network or a dedicated audiovisual network.	X	X	X	
IT-104	Network Security	Verify that the shared or dedicated network is secure as defined in the project documentation and accessible to suit the required audio, video, and control systems.	X	X	X	
IT-105	Telephony	Verify that any required telephony connections to the AV system are in place and connectivity is verified.	X	X	X	
IT-106	Unified Communications	Verify that any connections to IT-based unified communication applications that will interface with the AV system have been planned for and integrated.	X	X	X	
IT-107	AV IP Address Scheme	Verify and document that all network-connected equipment has the correct IP address, subnet mask, hostname, and gateway configuration as defined in the project documentation.	X	X		
IT-108	IEEE 802 Wireless Networks	Verify that the wireless network configuration is correct and valid (e.g., channel no., SSID, TX power) in defined areas of use as defined in the project documentation. Verify that there is adequate channel separation between any client wireless networks that are required to co-exist in the same area.	X	X		
IT-109	PoE (Power over Ethernet)	Verify that PoE (Power over Ethernet) devices are supplied with correct power required for normal device operation. Verify under normal operations that the switch providing PoE has the capacity to power all of the devices that are connected to it.	X	X		
IT-110	Network Topology	Verify that the network for audio, video, and control is of a suitable topology to support the services to be delivered as defined in the project documentation.	X			

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
IT-111	Application Integration	Verify that the audiovisual and control systems have been integrated and have been fully configured with headend software, including monitoring and asset management; databases; web-based front ends; digital signage software and systems; content generation and distribution platforms; and appliances as defined in the project documentation.		X	X	
IT-112	Enterprise Management Tools	Verify that enterprise management tools such as central monitoring client/server or web-based applications have been installed and connected to all systems they are required to monitor or control as specified in the project documentation.			X	
IT-113	Identity Management	Verify that all systems-authentication credentials are configured correctly. Any temporary credential used during system installation and commissioning should be removed. User and group authentication and authorization are verified based on the requirements from the project documentation. Connectivity with the central directory, database, or other identity authority should be verified.			X	
IT-114	Network Performance Under Full Functional Load	Verify that the network can provide the required operational performance to carry control, audio, video, and data under production load and at times of peak production load (refer to IT-102 Network Bandwidth).			X	
IT-115	Remote Access	Verify that remote access to AV and IT systems are configured as defined in the project documentation.			X	
IT-116	Remote Management	Verify that remote management tools such as virtual touch panels, internal web applications, or manufacturer's applications are configured and functional as required by the project documentation and/or manufacturer's specification.			X	

Operations and Support Verification Items

OP-100	Software	Verify that all control programming code, DSP configuration files, and any other associated software have been provided as defined in the project documentation.				X
OP-101	Battery Management Plan	Verify that a battery management plan has been completed and supplied to the owner in the project documentation package.	X			
OP-102	Content Management Plan	Verify there is a plan for managing the content to be delivered by the audiovisual systems, including the means to create content and update content when new information needs to be conveyed.	X			

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
OP-103	System Content Provided	Verify that any owner, vendor, or third-party-produced system content that is required for operations as defined in the project documentation has been supplied, loaded, and tested in the completed AV system.		X	X	

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
Physical Environment Reference Verification Items						
PHYSE-100	Divisible Spaces	Verify that the divisible spaces provide the functionality defined in the project documentation.	X	X	X	
PHYSE-101	Human Factors, Usability, and Ergonomics	Verify that ergonomics and usability elements for audience and system users are installed and configured as defined in the project documentation.	X	X	X	
PHYSE-102	Lighting	Verify that the lighting systems are suitable for each type of application (e.g., video conferencing, presentation, broadcast, performance) as defined in the project documentation.	X	X	X	
PHYSE-103	Vibration	Verify that the physical environment is suitable for the intended audiovisual systems in relation to all sources of vibration affecting stability of equipment such as videoconferencing cameras, document cameras, and fixed screen and projector locations.	X	X	X	
PHYSE-104	Backing/Blocking/Framing	Verify that installed backing, blocking, and framing meets project documentation requirements and industry standards for installation means and methods.	X			
PHYSE-105	Clean Building Handover	Verify that the area is clean, free of dust, and suitable for equipment installation and that no further work is planned that will release contaminants into any AV equipment area. Verify that the area released is isolated from any areas not yet released.	X			
PHYSE-106	Coordinated Construction Elements	Verify that the elements (including but not limited to spatial requirements and building services) required by the AV system and that are coordinated with other disciplines have been provided as defined in the project documentation.	X			
PHYSE-107	Device Enclosures	Verify that device enclosures accommodate the intended device and that all necessary environmental controls (e.g., heating, cooling, humidity) are incorporated into the enclosure as defined in the project documentation.	X			
PHYSE-108	Finishes	Verify AV equipment, furniture, fixtures, and accessories against the project documentation.	X			
PHYSE-109	Floor Boxes/Wall Boxes/Ceiling Boxes	Verify that installed floor, wall, and ceiling boxes meet project documentation and regulatory authority requirements.	X			
PHYSE-110	HVAC Commissioned	Verify the HVAC system has been tested and balanced prior to completing verification items AP-112 and AP-116.	X			
PHYSE-111	HVAC Operations	Verify the HVAC system has begun continuous operations in advance of equipment operations.	X			

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
PHYSE-112	Structural Mounting	Verify configuration and compatibility of structural accommodations and all mounting hardware based on the intended application. All equipment mounting hardware shall be installed in the manner specified by the hardware manufacturer.	X			
PHYSE-113	Protection of Installed Equipment	Verify that all elements of the AV system are free of damage.		X		
PHYSE-114	Accessibility	Verify that all systems are accessible in accordance with regulatory requirements.			X	

Physical Installation Reference Verification Items

PHYSI-100	Cable Containment/Conduit	Verify that installed containment/conduit capacity and routes meet project documentation requirements, industry standards, and regulatory requirements for installation means and methods. Verify that installed containment/conduit is serviceable and free of contaminants.	X			
PHYSI-101	AV Rack Air Flow and Temperature Performance	Verify that the AV rack(s) provides the air flow as required in the project documentation. Verify that the temperature in the AV rack has been measured and is within tolerances defined by manufacturers' guidelines and the project documentation. This verification item shall require a metric to be verified.		X	X	
PHYSI-102	Equipment Security	Verify that equipment is secured as defined in the project documentation. Verify that all security systems, devices, and manufacturer security accessories are installed and verified to be operating as defined in project documentation. Verify that keyed devices have been keyed as defined in the project documentation and devices requiring configuration have been configured as defined in the project documentation and are verified to be operating within specification.		X	X	
PHYSI-103	AV Equipment Labeling	Verify that all AV equipment has been labeled in accordance with the requirements of the project documentation. All labeling must be consistent, durable, accurate, and visible without dismantling of sub-assemblies.		X		
PHYSI-104	Plumb and Level/Square	Verify that all AV equipment has been installed, aligned, or angled correctly as defined in the project documentation. Level and plumb are the default requirement unless particular angles or other alignments are defined in the project documentation.		X		

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
PHYSI-105	Site Security	Verify that all elements of the AV system are free from loss, damage, or tampering.		X		
PHYSI-106	AV Equipment Located Per Project Documentation	Verify that AV equipment is installed at the location and/or in the rack or enclosure as defined in the project documentation. Equipment is installed per the elevation or other specification provided by the project documentation or the manufacturer's specification.			X	
PHYSI-107	AV Rack Cleanliness	Verify that all components installed in AV equipment racks are free from dirt, dust, water, or any other element that would compromise the performance and/or longevity of the AV system.			X	
PHYSI-108	Non-End User Controls Protection	Verify that installed items with user-facing controls that are not intended for end- user access have been covered, disabled, or otherwise secured to prevent end- user operation.			X	
PHYSI-109	Optical Components Cleanliness	Verify that all optical components, such as lenses and mirrors, are free from dirt, dust, damage, or markings that would compromise the optical performance of those system components.			X	
PHYSI-110	Handing of Accessories Otherwise Undefined	Verify that all items that are pre-packaged with primary system equipment but have no documented/planned use in the AV system(s) are managed in accordance with the project documentation.				X
PHYSI-111	Turnover of Accessory System Elements	Verify that any equipment that may be considered portable and/or otherwise not specifically incorporated into the installed AV system(s) has been set up, configured, and tested.				X

Item Number	Test	Description	Pre-Integration	Systems Integration	Post-Integration	Closeout
Serviceability Reference Verification Items						
SERV-100	Access Panels	Verify that any access panels that have been installed to provide access to any type of AV equipment are properly sized and positioned as detailed in the project documentation.	X	X		
SERV-101	Ability to Maintain and Service Equipment	Verify that all equipment is accessible and capable of being maintained, serviced, cleaned, or adjusted as necessary. Verify that all equipment requiring regular cleaning or maintenance is accessible without requirement for special equipment or tools that would disrupt the normal use of the facility and systems therein.			X	
SERV-102	Input and Output Panel Accessibility	Verify that all input and output panels are accessible and meet all requirements for user access and placement.			X	
SERV-103	Rack Clearance	Verify rack placement and use for physical stability in accordance with the project documentation and regulatory authority.			X	

Wireless Reference Verification Items

WL-100	Wireless Audio Systems Operation	Verify that the operation of wireless audio systems (RF and IR) is as defined in the project documentation.	X	X	X	
WL-101	Wireless Controls System Operation	Verify that the operation of wireless control systems (RF and IR) is as defined in the project documentation.	X	X	X	
WL-102	Wireless Coordination	Verify that the environment is suitable for the required wireless services (RF and IR) to provide audio, video, and control, and can be implemented for the required number of channels as defined in the project documentation.	X	X	X	
WL-103	Wireless Video Systems Operation	Verify that the operation of wireless video systems (RF and IR) is as defined in the project documentation.	X	X	X	

**SECTION 27 5319
EMERGENCY RESPONDER RADIO REINFORCEMENT SYSTEM**

PART 1 - GENERAL

1.01 SCOPE

- A. This section includes product and execution requirements for Emergency Responder Radio Reinforcement system.

1.02 DESCRIPTION

- A. Design and provision of a complete, turnkey Emergency Responder Radio Reinforcement system compliant with all applicable codes and standards referenced herein and as indicated on drawings.
- B. The Emergency Responder Radio Reinforcement system shall include the following major components:
1. Donor Antenna(s)
 2. Surge Protection
 3. Bi-Directional Amplifier / Repeater
 4. Splitters
 5. Directional Couplers/Taps
 6. Coverage Antennas
 7. Uninterruptible Power Supplies

1.03 RELATED WORK

- A. Related Division 27 Sections include:
1. Section 27 0000 - General Communications Requirements
 2. Section 27 0526 - Grounding and Bonding for Communications Systems
 3. Section 27 0528.29 - Hangers and Supports for Communications Systems
 4. Section 27 0528.33 - Raceway and Boxes for Communications Systems
 5. **[Consider which other Div 27 sections should be shown here]**
- B. Related sections in other Divisions of Work:
1. Section 26 4113 - Lightning Protection for Structures
 2. **[Consider which other division sections should be shown here]**

1.04 REFERENCES AND STANDARDS

- A. Unless otherwise noted, design, products, installation, and completed work shall conform with the current version of the following, including applicable addenda and errata:
1. United States Table of Frequency Allocations, current version
 2. Federal Communications Commission Table of Frequency Allocations, current version
 3. FCC 47 CFR Part 90.219
 4. FCC OET Bulletin 65
 5. IFC International Fire Code
 6. UL 2524-2018 Standard for In-building 2-Way Emergency Radio Communication Enhancement Systems
 7. NFPA 1: Fire Code
 8. NFPA 72: National Fire Alarm and Signaling Code
 9. NFPA 1221: Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems

1.05 ABBREVIATIONS AND ACRONYMS

- A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.
- B. In addition, following abbreviations and acronyms shall apply to this document:
1. ACG: Automatic Gain Control

2. AHJ: Authority Having Jurisdiction
3. ATP: Acceptance Test Plan
4. AWS: Advanced Wireless Service
5. BDA: Bi-Directional Amplifier
6. BOM: Bill-of-Material
7. BRS: Broadband Radio Service
8. BTS: Base Transceiver Station
9. CDMA: Code Division Multiple Access
10. C/N: Carrier-to-Noise Ratio
11. CWDM: Coarse Wave Division Multiplexing
12. DAS: Emergency Responder Radio Reinforcement System
13. DAS: Two-way Radio Communications Enhancement System
14. DAQ: Delivered Audio Quality
15. DWDM: Dense Wave Division Multiplexing
16. EBS: Educational Broadband Service
17. ESMR: Enhanced Specialized Mobile Radio
18. ERRC: Emergency Responder Radio Coverage
19. FCC: Federal Communications Commission
20. GUI: Graphical User Interface
21. iDEN: Integrated Enhanced Digital Network
22. LMR: Land Mobile Radio
23. LTE: Long Term Evolution
24. MIMO: Multiple-Input and Multiple-Output
25. MTBF: Mean Time Between Failure
26. NFPA: National Fire Protection Association
27. NMS: Network Management System
28. NTIA: National Telecommunications and Information Administration
29. PCS: Personal Communications System
30. PSE: Public Safety Entity
31. PSN: Public Safety Network
32. RF: Radio Frequency
33. RoF: Radio-over-Fiber
34. RoHS: Restriction of Hazardous Substances
35. RSL: Received Signal Level
36. RX: Receive
37. SISO: Single-Input, Single-Output
38. SMR: Specialized Mobile Radio
39. SMS: Short Message Service
40. SNMP: Simple Network Management Protocol
41. SOW: Statement of Work
42. TSL: Transmit Signal Level
43. TX: Transmit
44. VSWR: Voltage Standing Wave Ratio

1.06 DEFINITIONS

- A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.
- B. In addition, the following definitions are applicable to this document:
 1. Active: DAS components that require AC/DC power for operation
 2. Channel: A path for an RF transmission between two points
 3. Component: A main system element of the DAS

4. Contractor: The prime contractor bidding the project
5. Passive: DAS components that do not require AC/DC power for operation

1.07 WORK BY OWNER

- A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.08 SUBMITTALS

- A. Refer to Section 27 0000 - General Communications Requirements which provides general guidelines for product or installation information to be submitted by Contractor.
- B. In addition, Submit:
 1. Initial RF site survey and analysis report, to include:
 - a. Data collection point locations
 - b. RF spectrum shots
 - c. RF data plot maps
 2. Floor plans documenting proposed coverage antenna locations
 3. Floor plans documenting proposed donor antenna location
 4. RF propagation modeling maps
 5. Documentation that each PSN has reviewed and approved proposed equipment and Contractor's design
 6. Follow-up RF site survey and analysis report, to include:
 - a. Data collection point locations
 - b. RF spectrum shots
 - c. RF data plot maps
 - d. Documentation of changes to initial system design required due to results of follow-up RF site survey, where required, to include as applicable:
 - 1) Floor plans documenting proposed coverage antenna locations
 - 2) RF propagation modeling maps
 - 3) Documentation that each PSN has reviewed and approved proposed equipment and Contractor's design

PART 2 - PRODUCTS

2.01 GENERAL

- A. Equipment required to provide emergency responder radio coverage shall be listed in accordance with UL 2524.
- B. System shall be a BDA style turnkey system capable of integral support of RF signals for PSNs managed by FCC.
- C. System shall support each PSN on each frequency currently being used by PSEs serving project area.
 1. Coordinate directly with each PSE prior to the commencement of design work to confirm frequencies active on the project's scheduled date of substantial completion.
- D. System shall be expandable to support each frequency band allocated by FCC for PSN use without replacement of or addition to the system's passive infrastructure.
- E. System shall be capable of receiving PSN AHJ approval.
- F. System shall include filtering of all frequencies unused by PSN signals in area in which project is located.
- G. System shall be capable of upgrade, without need for additional hardware or software, to support changes to other frequencies within deployed frequency bands to maintain PSN coverage as originally designed.
- H. System shall be expandable to extend coverage for all Public Safety frequencies supported to future new additions without need for additional head end equipment.
- I. Passive system components shall be:

1. Broadband
 2. MIMO compatible
 3. PIM (passive intermodulation) compliant
- J. Active RF emitting devices used in emergency responder radio coverage systems shall have built-in oscillation detection and control circuitry.

2.02 ANTENNAS

- A. Broadband Donor Antenna
1. Antennas shall feature multi-band design accommodating applicable Public Safety frequencies in a single pole-mounted antenna.
 2. Temperature range: -40°F to 140°F.
 3. Rated for outdoor use.
- B. Coverage Antennas – Omnidirectional
1. Antennas shall feature multi-band design accommodating multiple frequency bands in a single ceiling-mounted antenna
 2. Antenna beam width:
 - a. Horizontal: 360° omnidirectional
 - b. Vertical: 65-80° nominal
 3. Temperature range: -40°F to 140°F.
 4. Rated for indoor use.
- C. Coverage Antennas - Directional
1. Antennas shall feature multi-band design accommodating multiple frequency bands in a single wall-mounted antenna
 2. Antenna beam width:
 - a. Horizontal: 110° directional
 - b. Vertical: 90° nominal
 3. Temperature range: -40°F to 140°F.
 4. Rated for indoor use.

2.03 BI-DIRECTIONAL AMPLIFIERS

- A. Where BDA is used to drive DAS, BDA shall be modular design and use digital filtering to mitigate interference.
- B. BDA shall be standard 19" rack or wall mountable.
- C. BDA shall be able to individually control power level of each frequency band amplified.

2.04 CABLING

- A. Feeder and riser coaxial cables shall be plenum rated.
- B. Backbone, antenna distribution, radiating, and fiber optic cables shall be plenum rated.

PART 3 - EXECUTION

3.01 PSN SUPPORT COORDINATION MEETING

- A. Prior to Contractor's design work commencement, Contractor shall arrange and conduct coordination meeting to review and coordinate Emergency Responder Radio Reinforcement system support of PSN frequencies.
1. At minimum, attendees shall include:
 - a. AHJ and representatives of public safety entities utilizing supported PSN frequencies
 - b. Owner's project manager, facilities/buildings and grounds/maintenance representative, security representative, and information technology/information systems representative
 - c. Construction Manager/General Contractor project manager and site superintendent/field foreman
 - d. Division 26 site superintendent/field foreman

- e. Division 27 project manager and site superintendent/field foreman
- f. Emergency Responder Radio Reinforcement subcontractor/supplier project manager
2. At minimum, meeting agenda topics shall include:
 - a. Confirmation of PSN frequencies and channel loading currently being used by PSEs serving project area
 - b. Identification of planned or potential changes in active frequencies and/or channel loading that may be implemented prior to scheduled date of substantial project completion
 - c. Identification and discussion of proposed system's functional capabilities and limitations
 - d. Step-by-step review of system design and deployment execution plan
 - e. Review of survey, design, installation, configuration, programming, and testing schedule and of how those relate to overall construction schedule, including identification of interdependencies, project milestones, and critical dates.
3. Meeting shall be scheduled with minimum of two weeks' notice.
 - a. Contractor shall publish meeting agenda and distribute agenda and configuration and programming guide to invited attendees minimum of one week prior to meeting.
4. Contractor shall take detailed notes during meeting and publish meeting minutes within one week after meeting. Minutes shall be distributed to attendees, Architect, and Engineer, and be included in Operation and Maintenance Manual.

3.02 PRE-DESIGN SITE SURVEY

- A. After specified coordination meetings and before completion of design, Contractor shall conduct pre-design site survey.
- B. Data collection points shall:
 1. Include potential donor antenna locations and elevations
 - a. Every effort shall be made to be accurate in locating potential donor antenna locations and elevations on site during survey, to ensure survey measurements are conducted within 10 feet of actual locations, including elevation.
 2. Be sufficient in quantity and location to provide accurate and sufficiently granular data throughout coverage areas
 3. Be sufficient in quantity and location to properly inform Contractor's design
- C. Survey measurements shall include:
 1. Baseline RF noise at and adjacent to supported frequencies
 2. Signal strength of each supported PSN's macro signals, at supported frequencies
- D. Survey data shall be submitted to Architect and Engineer and be included in Operation and Maintenance Manual.

3.03 DESIGN

- A. Where DAS is used in lieu of a two-way in-building wired emergency communications system, DAS design shall be approved by AHJ.
- B. Contractor is solely responsible for design of Emergency Responder Radio Reinforcement System.
- C. Contractor shall design Emergency Responder Radio Reinforcement System in accordance with manufacturer's instructions and recommendations, industry standard best practices, and requirements of supported PSNs. Where discrepancies arise, more stringent requirement will govern.
- D. Contractor shall design Emergency Responder Radio Reinforcement System to provide performance specified herein throughout the coverage areas and to meet approval of all supported PSNs.
- E. Refer to Architectural drawings for building occupant information.

3.04 PRE-INSTALLATION SITE SURVEY

- A. Contractor shall conduct pre-installation site survey no more than thirty (30) days prior to commencement of installation work on site to acquire updated measurement data.
 - 1. Pre-installation site survey shall be conducted after walls are built and after glazing is installed.
 - 2. Where pre-design site survey is conducted within thirty days of commencement of installation work and fulfills all requirements for both pre-design site survey and pre-installation site survey, separate pre-installation site survey is not required.
- B. Data collection points shall:
 - 1. Include potential donor antenna locations and elevations
 - a. Every effort shall be made to be accurate in locating potential donor antenna locations and elevations on site during survey, to ensure survey measurements are conducted within 10 feet of actual locations, including elevation.
 - 2. Be sufficient in quantity and location to provide accurate and sufficiently granular data throughout coverage areas
 - 3. Be sufficient in quantity and location to properly verify Contractor's design
- C. Survey measurements shall include:
 - 1. Baseline RF noise at and adjacent to supported frequencies
 - 2. Signal strength of each supported PSN's macro signals, at supported frequencies
 - 3. Continuous wave (CW) testing to validate propagation modeling
- D. Survey data shall be submitted to Architect and Engineer and be included in Operation and Maintenance Manual.
- E. Contractor shall update their design as required by updated survey data.

3.05 WORK SEQUENCE

- A. Coordinate schedule of Emergency Responder Radio Reinforcement system work to ensure Certificate of Occupancy is obtained in accordance with project schedule.

3.06 EQUIPMENT SUPPORTS

- A. Donor Antenna Mounts
 - 1. Donor antenna assemblies including antenna(s), antenna cable, antenna mount/mast, and associated accessories and hardware shall be designed and installed to withstand sustained winds of ≥ 100 miles per hour from any direction with all devices, equipment, and material installed and with up to 6 inches of radial ice accumulated.
 - 2. Make donor antenna mounts/masts and associated components, accessories, and hardware electrically continuous and properly ground to lightning protection system. Refer to Section 26 4113 for conductor sizing and termination requirements, and for additional information and requirements.

3.07 INSTALLATION

- A. Design and installation shall be performed and overseen by FCC GROL licensed technician employed by installing contractor.
- B. Equipment Locations
 - 1. Install antenna(s) in coverage areas. **[Refer to drawings for additional information.]**
 - 2. Install **[donor antenna and]** main system head end equipment where indicated on drawings. **[Refer to drawings for additional information.]**
 - 3. Install system floor-level equipment (splitters, directional couplers / taps, etc.) where indicated on drawings in telecommunications rooms. Refer to drawings for additional information.
 - 4. Active system components, including transmitter, receiver, signal booster components, external filters and battery system components, shall be contained in NEMA 4 or 4X enclosures.

- C. Power Supplies
 - 1. Primary power source
 - a. Emergency Responder Radio Reinforcement system active electronics shall be fed via minimum 20-amp emergency power electrical circuit(s), dedicated to Emergency Responder Radio Reinforcement system head end equipment.
 - 2. Secondary power source
 - a. System shall include battery back-up sufficient to power system at 100 percent system operation for minimum of twenty-four (24) hours.
 - 3. Power supply system shall be equipped with emergency power off (EPO) switch **[in location approved by fire code official][in Fire Command Center][adjacent to BDA or Signal Booster in an approved location]**. EPO shall disconnect both circuit breaker and secondary power supply simultaneously.
 - 4. Coordinate power requirements, quantities, connection locations, and schedule for activating power with on-site Division 26 Contractor prior to commencement of work on site.
- D. Cabling
 - 1. Where DAS is used in lieu of two-way in-building wired emergency communications system, DAS shall have pathway survivability of Level 1, Level 2, or Level 3.
 - 2. Riser cables shall be routed through 2-hour rated enclosure.
 - 3. Connection between riser and feeder cables shall be made within 2-hour rated enclosure.
 - a. Passage of feeder cable in and out of 2-hour rated enclosure shall be fire-stopped to 2-hour ratings.
- E. Properly ground system components with minimum 6 AWG bonding conductor terminated with two-hole compression lugs.
 - 1. Refer to Section 27 0526 for additional information and requirements.
- F. Provide and configure filtering to maximize composite power for PSN frequencies being supported.
- G. Properly terminate unused RF ports on system devices, including amplifiers, splitters, directional coupler / taps, etc.
- H. Donor Antennas
 - 1. Coordinate donor antenna locations and mounting method with Architect and GC prior to rough-in.
 - 2. Fasten donor antennas and associated mounting components. with stainless steel fasteners.
 - 3. Bond donor antenna cables to ground at point where cable connects to antenna and at point where cable transfers off antenna mounting structure.
 - 4. Provide in-line surge protection on antenna cables, at point where cable enters building.
 - a. Properly ground surge protection components with minimum 6 AWG bonding conductor terminated with two-hole compression lugs.
 - b. Refer to Section 27 0526 for additional information and requirements.
 - 5. Weatherproof exterior antenna cable connections with manufacturer-approved assembly.
- I. Coverage Antennas shall be installed **[in][above]** accessible ceilings[, **mounted to bottom of structure]**. Coordinate antenna locations with work by other trades to ensure that direct access to antenna is maintained after project completion.
- J. System shall provide uniform coverage. Radio coverage shall be provided throughout building as percentage of floor area.
 - 1. Building shall be considered to have acceptable emergency responder radio coverage when signal strength measurements in 95 percent of all areas on each floor of building meet signal strength requirements.
 - 2. Minimum signal strength of -95 dBm shall be receivable within the building.

3. Minimum signal strength of -95 dBm shall be received by agency's radio system when transmitted from within building.
 4. Critical areas, including fire command centers, fire pump rooms, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical by AHJ, shall be provided with 99 percent floor area radio coverage.
 - a. General building areas shall be provided with 90 percent floor area radio coverage.
 5. Minimum inbound signal strength sufficient to provide usable voice communications, as specified by AHJ, shall be provided throughout coverage area. Inbound signal level shall be sufficient to provide minimum of DAQ 3.0 for either analog or digital signals.
 6. Minimum outbound signal strength sufficient to provide usable voice communications, as specified by AHJ, shall be provided throughout coverage area. Outbound signal level shall be sufficient to provide minimum DAQ 3.0 for either analog or digital signals.
 7. Isolation shall be maintained between donor antenna and inside antennas to minimum of 20 dB under operating conditions.
- K. System shall not interfere with operation of other electronic systems.

3.08 SYSTEM MONITORING

A. Fire Alarm System

1. System shall include automatic supervisory signals for malfunctions of emergency responder radio reinforcement system annunciated by fire alarm system in accordance with NFPA 72.
 - a. Monitoring for system integrity shall comply with NFPA 72, Chapter 10.
 - b. Provide visual and labeled indications for each supervised system component.
 - c. System supervisory signals shall include:
 - 1) Donor antenna malfunction
 - 2) Active RF emitting device failure
 - 3) Low-battery capacity indication when 70 percent of the 24-hour operating capacity has been depleted
 - 4) System component failure
 - d. Power supply supervisory signals shall include the following for each RF emitting device and system component:
 - 1) Loss of normal AC power
 - 2) Failure of battery charger
 - e. Communications link between fire alarm system and emergency responder radio reinforcement system shall be monitored for integrity.

B. Dedicated Panel

1. Dedicated monitoring panel shall be provided within fire command center to annunciate status of RF emitting devices and system component locations. Monitoring panel shall provide visual and labeled indications of following for each system component and RF emitting device:
 - a. Normal AC power
 - b. Loss of normal AC power
 - c. Battery charger failure
 - d. Low battery capacity (to 70 percent depletion)
 - e. Donor antenna malfunction
 - f. Active RF emitting device malfunction
 - g. System component malfunction
2. Communications link between dedicated monitoring panel and emergency responder radio reinforcement system must be monitored for integrity.

3.09 INSPECTION AND TESTING

- A. Test plan shall include tests necessary to verify that installed system meets specified requirements and requirements of each PSE.
- B. Scheduling
 - 1. Testing shall be scheduled minimum of two weeks prior to scheduled date of final completion.
 - a. Contractor shall coordinate with each PSE to arrange for them to observe system testing.
- C. Data collection points
 - 1. Data collection points shall include:
 - a. All donor antenna locations
 - b. Signal level at each stair landing and elevator lobby
 - c. Signal level at locations as required by AHJ
 - 2. Be sufficient in quantity and location to properly verify that system's performance meets specified requirements and requirements of each PSE.
 - a. At a minimum, each floor shall be divided into twenty equal areas and data shall be collected at or as near as is practical to the center of each area.
- D. Survey measurements shall include:
 - 1. Baseline RF noise at and adjacent to supported frequencies
 - 2. Signal strength of each supported PSN's macro signals, at supported frequencies
 - 3. Signal strength of each supported PSN's system coverage signals, at all supported frequencies
- E. At no additional cost to Owner, Contractor shall adjust, modify, and/or add to system as necessary to achieve performance required by AHJ.

3.010 ATTIC STOCK

- A. Contractor shall provide following spare devices and equipment as Owner's attic stock:
 - 1. Donor Antennas: One (1) of each type provided
 - 2. Coverage Antennas: Five (5) of each type provided
 - 3. Surge Suppressors: 100% of the quantity installed of each type provided.
 - 4. Fuses: 20% of each type provided as part of system devices and equipment, minimum ten (10) of each type provided.

3.011 TRAINING

- A. Contractor shall provide to Owner's designated representative(s) a minimum of one (1) 4-hour on-site training session related to work under this section within thirty (30) days of substantial completion.

END OF SECTION

SECTION 28 0000
GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE

- A. This section details references, standards, guidelines, requirements and conditions common to all Division 28 work.
- B. Work under this Section and related sections is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.
- C. Systems constituting the Division 28 scope of work include:
 - 1. **[Security Systems Commissioning]**
 - 2. **[Security Systems Integration]**
 - 3. **[Electronic Access Control]**
 - 4. **[Video Surveillance]**
 - 5. **[Intrusion Detection]**
 - 6. **[Intercom]**
 - 7. **[Emergency Telephones]**
- D. Fire Detection and Alarm (28 46 00 **[28 31 13][28 31 16]**) is not included as part of these general requirements.

1.02 DESCRIPTION

- A. Intent of drawings and specifications is to obtain complete systems tested, adjusted, and ready for operation.
- B. Except as otherwise defined in greater detail, terms "provide", "furnish" and "install" as used in Division 28 contract documents shall have the following meanings:
 - 1. "Provide" or "provided" shall mean "furnish and install".
 - 2. "Furnish" or "furnished" does not include installation.
 - 3. "Install" or "installed" does not include furnishing.
- C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.
- D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.
- E. Included in this contract are connections to equipment provided by others. Refer to Architectural, Electrical, Integrated Automation, Mechanical, Security and final shop drawings for equipment being furnished under other sections for exact locations of outlets and various connections required.
- F. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions.
- G. Where architectural features govern location of work, refer to architectural drawings.
- H. Perform work in "neat and workmanlike" manner as defined in ANSI/NECA 1 "Standard Practices for Good Workmanship in Electrical Contracting".

1.03 RELATED WORK

- A. Related Division 28 Sections include:
 - 1. **[Section 28 0545 - Electronic Safety and Security Systems Integration]**
 - 2. **[Section 28 1000 - Electronic Access Control]**
 - 3. **[Section 28 5123 - Intercom Entry Systems]**
 - 4. **[Section 28 2000 - Video Surveillance]**

5. **[Section 28 3000 - Intrusion Detection]**
 6. **[28 32 36 Ring-Down Emergency Telephones]**
 7. **[28 46 00 [28 31 13][28 31 16] Fire Detection and Alarm Systems]**
- B. Related sections in other Divisions of Work:
1. Section 26 0593 – Electrical Systems Firestopping
 2. Section 27 0526 - Grounding and Bonding for Communications Systems
 3. Section 27 0528.29 - Hangers and Supports for Communications Systems
 4. Section 27 0528.33 - Raceway and Boxes for Communications Systems
 5. Section 27 0528.36 - Cable Tray for Communications Systems
 6. Section 27 0528.39 - Surface Raceways for Communications Systems
 7. Section 27 0549 - Seismic Anchorage and Restraints
 8. Section 27 0553 - Communications Systems Identification
 9. Section 27 1000 - Structured Cabling
 10. Section 27 1100 - Communications Equipment Room Fittings
 11. Section 27 1300 - Communications Backbone Cabling
 12. Section 27 1500 - Communications Horizontal Cabling
 13. Section 27 1600 - Communication Connecting Cords, Devices and Adapters
 14. Also refer to individual technical sections identified above.
- C. Temporary Services:
1. Refer to Division 01 - Temporary Facilities and Controls.
 2. **[Other]**
- D. Continuity of Service:
1. No service shall be interrupted or changed without permission from Architect and Owner. Obtain written permission before work is started.
 2. When interruption of services is required, persons concerned shall be notified and shall agree upon a time.
- E. Demolition:
1. Division 01 - Selective Demolition.
 - a. Not applicable to this Division of work.
 2. Division 02 - Building Demolition
 - a. Not applicable to this Division of work.
 3. Perform demolition as required to accomplish new work.
 - a. Remove abandoned wiring to source of supply.
 - b. Disconnect abandoned outlets and remove devices.
 - c. Remove abandoned outlets if conduit servicing them is abandoned and removed.
 - d. Provide blank cover for abandoned outlets that are not removed.
 - e. Disconnect communications systems in walls, floors, and ceilings scheduled for removal.
 4. Accomplish work in neat workmanlike manner to minimize interference; annoyance or inconvenience such work might impose on Owner or other contractors.
 5. Unless otherwise noted, remove from premises materials and equipment removed in demolition work.
 6. Equipment noted to be removed and turned over to Owner shall be delivered to Owner at place and time Owner designates.
 7. Where materials are to be turned over to Owner or reused and installed by Contractor, it shall be Contractor's responsibility to maintain condition of materials and equipment equal to that existing before work began. Repair or replace damaged materials or equipment at no additional cost to Owner.

8. Where demolition work interferes with Owner's use of premises, schedule work through Architect, Owner and with other contractors to minimize inconvenience to Owner. Architect must approve schedule before Contractor begins such work.
- F. Cleaning and Repair
 1. Clean and repair existing materials and equipment that remain or is to be reused.
- G. Concrete Work:
 1. Provide cast-in-place concrete as required by contract documents unless otherwise noted.
 2. Concrete shall comply with Division 03 - Concrete.
 3. Provide anchor bolts, metal shapes and templates required to be cast in concrete or used to form concrete for support of equipment.
- H. Painting:
 1. Furnish equipment with factory applied prime finish unless otherwise specified.
 2. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Engineer.
 3. Furnish one can of touch up paint for each factory finish, which will be final finished surface of product.
 4. **[Owner][Contractor]** is responsible for painting of plywood in Security Equipment Rooms. Refer to Drawings.

1.04 REQUIREMENTS OF REGULATORY AGENCIES

- A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of contract shall become part of this specification.
- B. Perform work in accordance with laws, codes, regulations, ordinances, etc. of the jurisdiction in which the project site is located and in accordance with Owner's published standards.
- C. Perform work in accordance with referenced standards, guidelines, and industry best practices.
- D. Perform work in accordance with manufacturer's instructions, guidelines, recommendations, etc.
- E. Where a discrepancy exists between laws, codes, regulations, ordinances, guidelines, industry best practices, Owner's published standards, manufacturer's instructions, manufacturer's guidelines, manufacturer's recommendations, etc. and contract documents, the most stringent requirement or direction that complies with laws, codes, regulations, and ordinances shall govern.
- F. Changes to work conveyed by contract documents made after letting of contract to comply with applicable laws, codes, regulations, ordinances, Owner's published standards, or contract documents or to comply with requirements of Authority Having Jurisdiction shall be made by Contractor without any cost to Owner.
- G. Contractor shall include in their bid costs to procure permits, licenses, approvals, etc. applicable to work performed, including:
 1. Costs to prepare documents for applications, submittals, etc. for review by Authority Having Jurisdiction
 2. Application, submittal, etc. charges, fees, taxes, etc.
 3. Contractor shall include in their bid costs for inspections of work performed related to permits, licenses, approvals, etc. or laws, codes, regulations, ordinances, or Owner's published standards.

1.05 REFERENCES AND STANDARDS

- A. Design, cable and component selection, and installation practices shall conform with following:
 1. Local Electrical Code
 2. Country, state and local health, safety and building codes
 3. Americans with Disabilities Act
 4. ADA Standards for Accessible Design

5. ASIS PAP.1-2012: Security Management Standard: Physical Asset Protection
 6. ASIS SPC.1-2009: Organizational Resilience: Security, Preparedness, and Continuity Management Systems - Requirements with Guidance for Use
 7. **[BICSI 002: Data Center Design and Implementation Best Practices]**
 8. **[FGI Guidelines for Design and Construction of Hospitals and Outpatient Facilities]**
 9. IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems
 10. IEEE 1100: Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems
 11. IEEE C2: National Electrical Safety Code
 12. ICC International Building Code
 13. ICC International Fire Code
 14. IEEE 81: IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
 15. IEEE 802.3af and 802.3at: Power-over-Ethernet Standards
 16. **[IEEE 802.3an: 10 Gigabit Standard]**
 17. IEEE 837: Standard for Qualifying Permanent Connections Used in Substation Grounding
 18. **[ISO 14644-1: Cleanrooms and Associated Controlled Environments — Part 1: Classification of Air Cleanliness by Particle Concentration]**
 19. NECA/BICSI 607: Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 20. **[NEMA VE 1: Metal Cable Tray Systems]**
 21. **[NEMA VE 2: Cable Tray Installation Guidelines]**
 22. NETA MTS: Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems
 23. NFPA 70: National Electrical Code
 24. NFPA 70B: Recommended Practice for Electrical Equipment Maintenance
 25. **[NFPA 99: Health Care Facilities Code]**
 26. NFPA 101: Life Safety Code
 27. NFPA 780: Standard for the Installation of Lightning Protection Systems
 28. NFPA 5000: Building Construction Safety Code
 29. NIST SP 800-63B: Digital Identity Guidelines
 30. TIA-606-C: Administration Standard for Telecommunications Infrastructure
 31. TIA-607-D: Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises Standard
 32. **[TIA-942-B: Telecommunications Infrastructure Standard for Data Centers]**
 33. **[TIA1005-A: Telecommunications Infrastructure Standard for Industrial Premises]**
 34. **[TIA-1179-A: Healthcare Facility Telecommunications Infrastructure Standard]**
 35. **[TIA-4966: Telecommunications Infrastructure Standard for Educational Facilities]**
 36. TIA-5017: Telecommunications Physical Network Security Standard
 37. TIA TSB-184: Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling
 38. TIA TSB-185: Environmental Classification (MICE) Tutorial
 39. TIA TSB-190: Guidelines on Shared Pathways and Shared Sheaths
 40. Underwriters Laboratories Standards applicable to scope of work specified herein
 41. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
 42. Standards identified in individual Technical Sections.
 43. Standards identified in other Divisions and Sections referenced herein.
 44. **[OTHER]**
- B. Agencies or publications referenced herein refer to the following:

1. ANSI American National Standards Institute
2. ASIS American Society of Industrial Security
3. ASME American Society of Mechanical Engineers
4. ASTM American Society for Testing and Materials
5. BICSI Building Industry Consulting Services International
6. FIPS Federal Information Processing Standards
7. FCC Federal Communications Commission
8. ICEA Insulated Cable Engineers Association
9. IEEE Institute of Electrical and Electronics Engineers
10. NEC National Electrical Code
11. NECA National Electrical Contractors Association
12. NEMA National Electrical Manufacturers Association
13. NESC National Electrical Safety Code
14. NETA National Electrical Testing Association
15. NFPA National Fire Protection Association
16. NIST National Institute of Standards and Technology
17. OSHA Occupational Safety and Health Administration
18. TIA Telecommunications Industry Association
19. UL Underwriters Laboratories, Inc.

- C. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.06 DEFINITIONS

- A. The following definitions are applicable to security environments and shall apply to this document and its companion sections for clarification and direction.
1. Auxiliary Intelligent Controllers (AIX) or Auxiliary I/O Controllers (AIO): Controllers that are located near a served access control door and not in the Master Intelligent Controller location.
 2. Cable: Assembly of one or more conductors or optical fiber strands within enveloping sheath, constructed so as to permit use of conductors singly or in groups.
 3. Cable ID: Unique alpha-numeric identification used for tagging of backbone or horizontal cabling.
 4. Configuration: Initial physical and logical connection and set up of equipment and devices to provide specified features and functionality
 5. Contractor: Electronic Safety and Security Contractor or sub-contractor(s) responsible for installation, termination, test and documentation of Electronic Safety and Security equipment, devices, cabling, pathway hardware, equipment room hardware, and related components detailed in technical sections of this Division of work.
 6. Controller Location: Location in building having Master or Auxiliary Intelligent Controller. Where this term is presented with an initial capital letter, this definition applies.
 7. Credential: Data assigned to an entity and used to identify that entity.
 8. Entrance Facility: An entrance to building for both public and private network service cables and/or wireless services including entrance point of building and continuing to Entrance Room.
 9. Entrance Room: Room where both public and private network service cables and/or wireless services are terminated. Service provider(s) point-of-demarkation (DEMARC) is typically located here.
 10. Equipment Room (Electronic Safety and Security): An environmentally controlled centralized space for Electronic Safety and Security equipment that usually houses head end equipment, servers, control panels, power supplies, and systems wiring and cabling terminations.

11. **[Equipment Intermediate Distribution Facility: Centralized space for security, building automation, fire alarm and/or other low-voltage equipment. (An AEI-term).]**
12. F/UTP: Foiled Unshielded Twisted Pair. No shielding around individual pairs and an overall foil shield under the cable jacket.
13. Guarantee: Promise or an assurance that attests to quality or durability of product or service or that task will be performed in specified manner. Used interchangeably with "Warranty" in these documents.
14. Identifier: Credential card, keypad personal identification number, or code, biometric characteristic, or other unique identification entered as data into entry-control database for purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
15. Intelligent Controller: Access control controller containing a database of credential holders and system operation parameters that allow it to operate independently from system Server when communications between Server and the Intelligent Controller is not available.
16. Intra-building: Within single building.
17. Inter-building: Between 2 or more buildings.
18. I/O controllers: Input/Output controllers that provide a wiring interface to field devices,
19. IP Telephony: Use of [Internet Protocol \(IP\)](#) for two-way transmission of conversations. Also referred to as "Voice over Internet Protocol (VoIP)".
20. Lightning Protection Zone (LPZ): IEC standard (62305-4) for lightning protection. The Lightning Protection Zone concept is based on the idea of gradually reducing lightning energy to a safe level so that it won't cause damage to terminal device.
21. Master Intelligent Controller (MIC): Intelligent controller that connects to Auxiliary Intelligent Controllers or Auxiliary I/O controllers over TCP/IP or RS-232 / RS-422 / RS-485 communications networks.
22. PC: Personal computer. Applies to main and auxiliary workstations.
23. Programming – Implementation of owner-, customer-, user-, project- or site-specific system settings to complete system functionality.
24. Proximity: Credential technology that is based on electro-magnetic principles and incorporates specially treated wires embedded in the credential.
25. Rack Unit: Standard measurement of vertical mounting space on an equipment rack. Each Rack Unit is 1-3/4" high.
26. Server: Computer configured as access control system application and file server.
27. Service Loop: Surplus cable, typically located at or near point of termination, to enable future changes.
28. S/FTP: Screened Foiled Twisted Pair. Individual foil shield around each individual pair and an overall braided shield under the cable jacket.
29. SF/UTP: Screened Foiled Unshielded Twisted Pair. No shielding around individual pairs and overall foil and braided shields under the cable jacket.
30. S/UTP: Screened Unshielded Twisted Pair. No shielding around individual pairs and an overall braided shield under the cable jacket.
31. U/FTP: Unshielded Foiled Twisted Pair. Individual foil shield around each individual pair and no overall braided shield under the cable jacket.
32. UTP: Unshielded Twisted Pair. No shielding around pairs nor overall under cable jacket.
33. Voice over Internet Protocol: Refer to IP Telephony.
34. WAV: Usually uncompressed lossless computer file format used for storage of digital audio data.
35. Wiegand: Cable and signal protocol
36. Windows: Operating system by Microsoft Corporation.
37. Workstation: PC with software that is configured for specific, limited security-system functions.

38. Workstation, Auxiliary: Workstation that provides an auxiliary location for system management more geographically convenient for some staff than the Main Workstation
 39. Workstation, Main: Workstation that is primarily used for system management
- B. Typical NEMA Enclosures and Usage
1. Refer to Section 26 0000 – General Electrical Requirements.
 2. [NEMA 1 - Indoors. Falling dirt
 3. NEMA 2 - Indoors. Falling dirt. Falling liquids. Light splashing
 4. NEMA 3 - Outdoors. Sleet, snow, rain. Windblown dust
 5. NEMA 3X - Same as NEMA 3 plus corrosion resistant
 6. NEMA 3S - Same as NEMA 3 plus mechanism operable when ice covered
 7. NEMA 3SX - Same as NEMA 3S plus corrosion resistant
 8. NEMA 3R - Outdoors. Rain, snow, sleet
 9. NEMA 3RX - Same as NEMA 3R plus corrosion resistant
 10. NEMA 4:
 - a. **Indoors - Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down**
 - b. **Outdoors - Rain, sleet, snow. Wind blown dust. Hose down**
 11. **NEMA 4X - Same as NEMA 4 plus corrosion resistant**
 12. **NEMA 5 - Indoors. Falling Dirt. Falling Liquids. Settling dust, lint and fibers**
 13. **NEMA 6:**
 - a. **Indoors - Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down. Temporary submersion.**
 - b. **Outdoors - Rain, snow, sleet. Windblown dust. Hose down. Temporary submersion.**
 14. **NEMA 6P:**
 - a. **Indoors - Same as NEMA 6 / Indoors plus corrosion resistant. Prolonged submersion.**
 - b. **Outdoors - NEMA 6 /Outdoors plus corrosion resistant. Prolonged Submersion.**
 15. **NEMA 7 - Indoors. Class I, Division 1 or 2, Groups A, B, C or D. (Flammable gas).**
 16. **NEMA 9 - Indoors. Class II, Division 1 or 2. Groups E, R, or G. (Combustible dust).**
 17. **NEMA 12 - Indoors. Falling Dirt. Falling liquids. Flying dust, lint and fibers. Oil or coolant seepage.**
 18. **NEMA 13 - Same as NEMA 12 plus oil or coolant spraying or splashing.]**

1.07 ABBREVIATIONS AND ACRONYMS

- A. The following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction.
1. 8P8C Eight-Position, Eight-Conductor. Used in clarifying jack type; a.k.a. "RJ-45".
 2. ACMS Access Control **[and Alarm]** Monitoring System
 3. AFF Above Finished Floor
 4. ATM Asynchronous Transfer Mode
 5. AWG American Wire Gauge
 6. BAS Building Automation Systems
 7. BTU British Thermal Unit
 8. CDDI Copper Distributed Data Interface (Cisco Systems trade name for TP-PMD)
 9. cm centimeters
 10. CM Communications cable rated for General Purpose use
 11. CMP Communications cable rated for use in Plenum areas
 12. CMR Communications cable rated for use in Risers and vertical runs
 13. CP Consolidation Point
 14. CPU Central processing unit.

North Florida Innovation Labs
50% Construction Documents

15. °C	degrees Celsius
16. °F	degrees Fahrenheit
17. DTMF	Dual Tone Multi Frequency
18. EAC	Electronic Access Control
19. EIA	Electronic Industries Alliance
20. EF	Entrance Facility
21. ELFEXT	Equal-Level Far-End Cross Talk (pair-to-pair)
22. ER	Entrance Room
23. EIDF	Equipment Intermediate Distribution Facility
24. FDDI	Fiber Distributed Data Interface
25. FEXT	Far-End Cross Talk
26. ft	feet
27. GbE	Gigabit Ethernet
28. HC	Horizontal Cross-connect
29. HCP	Horizontal Connection Point (e.g. for TIA-862)
30. Hz	Frequency in Hertz (k = kilo, M = Mega, G = Giga)
31. ID	Inside Diameter
32. IDF	Intermediate Distribution Frame
33. in	inch
34. IPT	IP Telephony
35. kg	kilogram
36. lbs	pounds
37. LAN	Local Area Network
38. MATV	Master Antenna Television
39. MC	Main Cross-connect
40. MDF	Main Distribution Frame
41. MTR	Main Telecommunications Room
42. m	meters
43. mm	millimeters
44. Mbps	Megabits per second
45. μm	micrometer (10 ⁻⁶ meter)
46. N	Newton
47. NEXT	Near End Cross Talk
48. OD	Outside Diameter
49. OFNP	Optical Fiber Nonconductive Plenum
50. OFNR	Optical Fiber Nonconductive Riser
51. OTDR	Optical Time Domain Reflectometer
52. PBX	Private Branch Exchange (Telephone Switch)
53. pF	pico-Farad (10 ⁻¹² Farad)
54. PoE	Power-over-Ethernet
55. PSNEXT	Power Sum Near End Cross Talk
56. PVC	Polyvinyl Chloride
57. RF	Radio Frequency.
58. ROM	Read-Only Memory. ROM retains data through power losses.
59. RU	Rack Unit
60. sq ft	square feet (area)
61. TCP/IP	Transport Control Protocol / Internet Protocol
62. TO	Telecommunications Outlet
63. TP-PMD	Twisted Pair Physical Medium Dependent
64. TR	Telecommunications Room
65. UPS	Uninterruptible Power Supply

- 66. USB Universal Serial Bus
- 67. USOC Universal Service Ordering Code
- 68. VoIP Voice over Internet Protocol
- 69. WAN Wide Area Network
- 70. WLAN Wireless Local Area Network
- 71. WMP Windows Media Player

B. Refer also to technical sections for additional terminology.

1.08 LISTING

A. Refer to technical sections of this Division of work for listing requirements.

1.09 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section:

1. Refer to Division 01 - Submittal Procedures.
2. Provide documentation demonstrating compliance with requirements specified in 280000 - 1.13 - Quality Assurance below.
3. Note that for satisfying submittal requirements for Division 28, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, expression "Shop Drawings" is generally used throughout specification.
4. Mark catalog sheets and drawings to indicate specific items submitted.
 - a. Markings shall be reproducible (arrow, boxed, encircled, checkmark, etc.).
 - b. Where sheet includes multiple product options, mark proposed option(s).
5. Include proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
6. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Mark and annotate submittals accordingly.
7. Group submittals by Section to include complete documentation of related systems, products and accessories. Where applicable, dimensions shall be marked in units to match those specified.
8. Submittals shall be in electronic form or on paper per Division 01.
 - a. Documents in electronic form shall be *ADOBE Acrobat* PDF.
 - b. Paper documents shall be original catalog sheets or photocopies thereof.
 - c. Facsimile (fax) sheets will not be accepted.
9. Engineer's Review is to confirm compliance with performance, interoperability, physical, and other pertinent requirements of project. Review is not to confirm quantities nor that all required items have been submitted.
10. When equipment and items specified include accessories, parts and additional items under one designation, submittals shall be complete and include required components.
11. Include wiring diagrams for electrically powered or controlled equipment.
12. Submit equipment room layouts drawn to scale, including equipment, raceways, accessories and clearance for maintenance.
13. Where submittals cover products containing potentially hazardous non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
14. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
15. Submittals, which are not complete, not permanent, or not properly checked by Contractor, will be returned without review.
16. "Coordination Drawings", which are normally prepared by Contractor to coordinate work among various trades and to facilitate installation, shall not be submitted for Division 28 work unless specifically requested in technical sections. These types of drawings typically include dimensioned piping, ductwork, communications and/or electrical raceway layouts.

- a. Unless specifically requested in Division 28 technical sections, submittals of coordination drawings will be returned without review.
- B. Certificates and Inspections:
 1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.
- C. Operation and Maintenance Manuals:
 1. Refer to Division 01 - Operation and Maintenance Data.
 2. Upon completion of work but before final acceptance of system, submit to Architect for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy" is larger than 2" thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.
 3. Manuals shall be organized by specification section number and shall have table of contents and tabs for each piece of equipment or system.
 4. Manuals shall include the following:
 - a. Copies of shop drawings
 - b. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment. Where manufacturer's data includes several types or models, applicable type or model shall be designated.
 - c. CD ROM's of O&M data with exploded parts lists where available
 - d. Phone numbers and addresses of local parts suppliers and service companies
 - e. Internet/WEB page addresses where applicable
 - f. Wiring diagrams
 - g. Start up and shut down procedure
 - h. Factory and field test records
 - i. Additional information, diagrams or explanations as designated under respective equipment or systems specification section
 5. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
 6. O&M manuals and instructions to Owner shall be provided prior to request for final payment.
- D. Record Documents:
 1. Refer to General Conditions of Contract, and Division 01 - Closeout Procedures. Prepare complete set of record drawings in accordance with Division 01.
 2. Use designated set of prints of contract documents as prepared by Architect to mark-up for record drawing purposes.

1.010 JOB CONDITIONS

- A. Building Access:
 1. Arrange for necessary openings in building to allow for admittance of all apparatus.
- B. Cutting and Patching:
 1. Refer to General Conditions of Contract, and Division 01 - Cutting and Patching.
 2. Perform cutting and patching required for complete installation of systems unless otherwise noted. Patch and restore work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.
 3. Provide materials required for patching unless otherwise noted.
 4. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
 5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

- C. Housekeeping and Cleanup:
 - 1. Refer to Division 01 - Closeout Procedures.
 - 2. Periodically as work progresses and/or as directed by Architect, remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.011 WORK BY OWNER

- A. Owner will provide:
 - 1. **[Telecommunications service, including voice and data / internet]**
 - 2. **[Active telephone electronics, including analog/digital/VoIP private branch exchange (PBX), telephones, fax machines, and modems, for interface with building structured cabling systems]**
 - 3. **[Active Ethernet networking electronics, including modems, routers, firewalls, switches, wireless Ethernet access points, for interface with building structured cabling systems]**
 - 4. **[Active office electronics, including server computers, data storage appliances, workstation computers, scanners, and printers]**
 - 5. **[Connections from active telephone and Ethernet networking electronics to Contractor provided structured cabling.]**
 - 6. **[Connections from Backbone Voice Cables to Horizontal Voice Cables.]**
 - 7. **[Equipment Racks and/or Cabinets]**
 - 8. **[XXX]**

1.012 QUALITY ASSURANCE

- A. Refer to the individual technical sections for general product quality requirements, manufacturer qualifications, and contractor qualifications and certification requirements.
- B. Products
 - 1. Only products of reputable manufacturers, as determined by Architect/Engineer, will be acceptable. Manufacturers shall have minimum of **[five (5)] [ten (10)]** years of documented experience in designing, manufacturing, delivering, and supporting specified material.
 - 2. Where contract documents require a product, material, or assembly that hasn't been specified by brand or trade name, provide product, material, or assembly meeting specified requirements, as supplied and warranted by system vendor. If system vendor does not offer product, material, or assembly, provide product, material, or assembly per system vendor's recommendation.
- C. Contractor
 - 1. Contractor shall have minimum of **[five (5)] [ten (10)]** years' documented experience providing and servicing specified equipment, devices, components, materials, and systems.
 - 2. Contractor shall have documented history of successfully completing minimum of **[three (3)] [five (5)]** projects of scope and magnitude equal to or greater than that specified in Contract Documents.
 - 3. Contractor shall have a minimum of five (5) years' documented history of being continuously current on manufacturer's training and certifications applicable to specified equipment, devices, components, materials, and systems they propose for use on project.
 - 4. Contractor shall have a minimum of five (5) years' documented history of being certified by manufacturer to offer and support manufacturer warranties applicable to specified equipment, devices, components, materials, and systems they propose for use on project.
 - 5. Contractor's staff assigned as project manager, site superintendent, and foreman shall each have documented history of successfully completing minimum of **[three (3)] [five (5)]** projects of scope and magnitude equal to or greater than that specified in Contract Documents.

6. Contractor's staff assigned as site superintendent and foreman and Contractor's staff assigned to perform installation, termination, configuration, programming, and testing shall have minimum of **[three (3)] [five (5)]** years' documented experience of being continuously, individually certified by manufacturer on specified equipment, devices, components, materials, and systems proposed and approved for use on project.
7. Contractor shall have in-house service department staffed with technicians who are individually manufacturer-certified to install and service specified equipment, devices, components, materials, and systems proposed and approved for use on project, and who are equipped with tools, equipment, materials, etc. necessary to install and service specified equipment, devices, components, materials, and systems proposed and approved for use on project.
 - a. Contractor's in-house service department shall offer maximum **[8-hour] [4-hour] [2-hour]** on-site service call response time 24 hours a day, 7 days a week, 365(6) days a year.
8. Contractor and subcontractor(s) shall only employ workers who are properly trained to execute work being performed and are skilled in their trade.
9. Contractor and subcontractor(s) shall own and maintain equipment, tools, etc. to execute work performed in manner consistent with laws, codes, regulations, ordinances, standards, guidelines, industry best practices, manufacturer's instructions, etc.. Workers shall be properly trained in use of equipment, tools, etc. necessary for them to complete work performed.
10. Inability to demonstrate compliance with requirements listed above shall disqualify Contractor from self-performing work conveyed by contract documents, and Contractor shall then, at no additional cost to Owner, subcontract with another firm qualified to perform work.

D. **[OTHER]**

1.013 GUARANTEE

- A. Refer to Division 01 for general Guarantee (Warranty) requirements.
- B. Refer to technical sections for Guarantee requirement for each system.
 1. Where no guarantee requirements are called out, guarantee **[as called out in Division 01] [for one year [two years] after acceptance by Owner]** equipment, materials, and workmanship to be free from defect.
- C. Repair, replace or alter systems or parts of systems found defective at no extra cost to Owner.
- D. Wherein fulfilling requirements of any guarantee, if Contractor disturbs any work guaranteed under another contract, restore such disturbed work to condition satisfactory to Architect and guarantee such restored work to same extent as it was guaranteed under such other contract.
- E. Guarantees shall include labor, material and travel time.

1.014 ANNUAL SERVICE CONTRACT

- A. Provide annual cost and complete terms and conditions for extended service and maintenance warranty after the first year for the **[Electronic Access Control] [Intercom] [Video Surveillance] [Intrusion Detection]** system[s] in accordance with the following terms:
 1. Project warranty term shall begin on the date of **[system acceptance] [final acceptance] [Owner's first occupancy]** and shall continue for one (1) year.
 2. If accepted by Owner, extended service and maintenance warranty term shall begin upon expiration of project warranty. At the Owner's option, the term may be automatically renewed for successive one-year periods unless cancelled by the Owner.
 3. Annual cost quoted for extended service and maintenance warranty shall include in the base cost each item and service listed herein, including equipment, devices, materials, parts, firmware, software, labor, travel, etc.

4. Service and maintenance provided under the base annual cost for extended service and maintenance warranty shall include:
 - a. Repair or replace any system equipment item that fails to perform as initially installed, as specified, or as determined per the manufacturer's performance criteria.
 - b. Perform semi-annual preventive maintenance on the system equipment. This preventive maintenance shall include, but is not limited to, cleaning, realignment, inspection, and testing. The Owner shall receive a written report of these inspections that documents system equipment and device status and, if required, a list of all necessary repairs or replacements.
 - c. Provide software maintenance on the system. Install and configure each manufacturer-provided firmware and software update. Any additional software options, updates, or enhancements purchased by the Owner shall be installed. The Contractor shall not be responsible for the purchase of additional software packages or the maintenance of Owner data.
 5. Owner shall compensate Contractor for repairs or maintenance required as a result of Owner abuse, misuse, intentional damage, accidental damage, or power fluctuations exceeding specified equipment tolerances.
 6. System defects or failures shall be corrected within four (4) hours on the same business day if the Owner makes a service request before 11:00 a.m., or before 12:00 noon the next business day if the Owner makes the request after 11:00 a.m. If requested by the Owner, the Contractor shall respond or remain at the site after normal business hours, and the Owner shall reimburse the Contractor for the incremental cost difference between premium labor rates and standard labor rates. This reimbursement applies to premium labor rates that do not exceed time-and-one-half rates after normal business hours and double-time rates for Sundays and holidays. The Contractor's services shall be performed in a good and workmanlike manner and remain free from defects for a period of one (1) year following completion of service.
- B. The Owner will enter into a contract directly with the vendor. This specification is not a contract between the Owner and the vendor to perform these services.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide new materials, unless specifically noted otherwise in the contract documents.
- B. Where manufacturer has replaced part number with newer part number, provide material version that is manufacturer's most current offering available at time of installation.
- C. Where manufacturer has published end of life or similar notice for part number, notify Architect/Engineer of notice and manufacturer's recommended substitution. Where manufacturer offers no substitution, provide Architect/Engineer three (3) options for acceptable alternates.
- D. Where multiple manufacturers' names or manufacturers' names and part numbers are listed, basis of design listed shall be considered benchmark for quality, features, and functionality for that material.
- E. Include hardware, details, options, modules, accessories, subassemblies, etc. not shown or specified, but necessary for proper installation and operation.
- F. Where one or more of same item of material is required, all such units shall be provided as same manufacturer and part number.
- G. Refer to technical sections for additional information and requirements.

2.02 PRODUCT SUBSTITUTIONS

- A. Refer to Division 01 - Product Requirements.

- B. Unless noted otherwise and in accordance with Division 01, prior to submittal submission Contractor may choose to propose equivalent material from another manufacturer not listed herein.
 - 1. Refer to Division 01 for product substitution request requirements.
 - 2. Where Contractor chooses to propose other material they believe to be equivalent, Contractor is solely responsible for demonstrating that alternate material being proposed meets requirements specified in project documents for that material, is demonstrably equivalent to listed basis of design, and fits in the allocated space.
 - 3. Architect/Engineer shall make final determination as to whether the proposed alternate material is equivalent and acceptable for use on the project.

2.03 [FEDERAL ACQUISITION REGULATION]

- A. **[Product procurement shall comply with Federal Acquisition Regulation.]**
- B. **[Refer to Division 01 for additional information and requirements.]**

2.04 [ILLINOIS STEEL PRODUCTS PROCUREMENT ACT]

- A. **[Steel products shall comply with conditions of Illinois Steel Products Procurement Act.]**

2.05 [LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN]

- A. **[Products shall comply with Leadership in Energy and Environmental Design (LEED) requirements and contribute to accumulation of LEED Credits being pursued. Refer to [Division 01] [Section ##] for additional information and requirements.]**

PART 3 - EXECUTION

3.01 GENERAL

- A. Verify elevations and measurements prior to installation of materials.

3.02 [LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN]

- A. Refer to [Division 01] [Section ##] for additional information and requirements.
- A. **[Sustainable Architecture and LEED Requirements:**
 - 1. **Provide services, documentation, and product data required to meet LEED credits involving an Electronic Safety and Security component such as:**
 - a. **Credit SS Prerequisite 1 – Construction Activity Pollution Prevention**
 - b. **Credit EA Prerequisite 2 – Minimum Energy Performance**
 - c. **Credit EA 1 – Optimize Energy Performance**
 - d. **Credit EA 3 – Enhanced Commissioning**
 - e. **Credit EA 5 – Measurement and Verification**
 - f. **Credit MR 2 – Construction Waste Management**
 - g. **Credit MR 4 – Recycled Content**
 - h. **Credit MR 5 – Regional Materials**
 - i. **Credit EQ 4.1 – Low Emitting Materials, Adhesives & Sealants**
 - j. **Credit EQ 4.2 – Low Emitting Materials, Paints & Coatings**
 - k. **Credit EQ 6.1 – Controllability of Systems]**
- B. **[Sustainable Architecture and LEED Requirements:**
 - 1. **Provide services, documentation, and product data required to meet LEED credits involving an Electronic Safety and Security component such as:**
 - a. **Prerequisite SS – Construction Activity Pollution Prevention**
 - b. **Prerequisite EA – Minimum Energy Performance**
 - c. **Credit EA – Enhanced Commissioning**
 - d. **Credit EA – Optimize Energy Performance**
 - e. **Prerequisite MR – Construction and Demolition Waste Management Planning**

- f. **Credit MR – Building Product Disclosure and Optimization – Environmental Product Declarations**
 - g. **Credit MR – Building Product Disclosure and Optimization – Sourcing of Raw Materials**
 - h. **Credit MR – Building Product Disclosure and Optimization – Material Ingredients**
 - i. **Credit MR – Construction and Demolition Waste Management**
 - j. **Credit MR 4 – Recycled Content**
 - k. **Credit MR 5 – Regional Materials**
 - l. **Credit EQ – Low Emitting Materials**
 - m. **Credit EQ – Acoustic Performance**
 - n. **Credit ID – Innovation**
- C. **[Sustainable Architecture and LEED Requirements:**
- 1. **Provide services, documentation, and product data required to meet LEED credits involving an Electronic Safety and Security component such as:**
 - a. **Prerequisite SS – Construction Activity Pollution Prevention**
 - b. **Prerequisite EA – Minimum Energy Performance**
 - c. **Credit EA – Enhanced Commissioning**
 - d. **Credit EA – Optimize Energy Performance**
 - e. **Prerequisite MR – Construction and Demolition Waste Management Planning**
 - f. **Prerequisite MR – PBT Source Reduction - Mercury**
 - g. **Credit MR – Building Product Disclosure and Optimization – Environmental Product Declarations**
 - h. **Credit MR – Building Product Disclosure and Optimization – Sourcing of Raw Materials**
 - i. **Credit MR – Building Product Disclosure and Optimization – Material Ingredients**
 - j. **Credit MR – PBT Source Reduction - Mercury**
 - k. **Credit MR – PBT Source Reduction – Lead, Cadmium, and Copper**
 - l. **Credit MR – Design for Flexibility**
 - m. **Credit MR – Construction and Demolition Waste Management**
 - n. **Credit MR 4 – Recycled Content**
 - o. **Credit MR 5 – Regional Materials**
 - p. **Credit EQ – Low Emitting Materials**
 - q. **Credit EQ – Acoustic Performance**
 - r. **Credit ID – Innovation]**

3.03 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Division 01 for additional information and requirements.
- B. Transport, handle, and store materials in manner that avoids damage, preserves their original condition as delivered from manufacturer, is consistent with manufacturer's guidelines and instructions, and maintains applicable manufacturer warranties.
 - 1. Protect material from deleterious substances, agents, contaminants, and conditions, including dust, dirt, debris, moisture, chemicals, chemical compounds, corrosion, temperatures outside material's published tolerance range.
 - 2. Protect material from damage due to intentional or incidental contact, vandalism, neglect, etc.
- C. Handle materials in accordance with recommended procedures, precautions, and remedies described in material safety data sheets, where applicable.
 - 1. Where applicable, lift only with lugs provided for purpose.
- D. Store materials in clean, dry, secure, temperature-controlled location.
- E. Maintain manufacturer's original material packaging and shipping packaging until material is installed.

- F. Contractor shall include in their bid costs to deliver, store, and handle materials.

3.04 WORK LOCATIONS

- A. Field-verify locations, elevations, measurements, etc. prior to material installation.
- B. Electronic Safety and Security equipment and device locations shown on drawings are diagrammatic and shall not be used for dimensioning of final locations. Field-coordinate locations, elevations, measurements, etc. with Owner and with other trades prior to material installation.
1. Where architectural features govern work location and where areas are dense with work of multiple trades, refer to Architectural contract documents.
 2. Where work by other trades governs work location, refer to the contract documents of other trade.
 3. Check, verify, and coordinate work with other trades' contract documents and include modifications, relocations, adjustments, etc. necessary to complete work and prevent interference with other trades.
 4. Contract includes connections to equipment provided by others. Refer to other trades' contract documents and to final shop drawings for exact equipment, device and connection locations.
- C. Locate equipment and devices to fit space conditions. Owner and Architect reserve right to make minor position changes of equipment and device locations before work has been installed.
- D. Contractor shall survey site and include in their bid costs to perform work as specified in contract documents.
- E. Where conditions on site require adjustments to indicated locations and/or arrangements of equipment and devices, Contractor shall make required changes at no additional cost to Owner.

3.05 FLOOR, WALL, ROOF AND CEILING OPENINGS

- A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide during progress of construction sleeves and inserts that are to be built into structure.
- B. Temporary sleeves, if used to form wall openings, shall be removed prior to installation of permanent materials. Permanent sleeves for wall penetrations shall be minimum 24 ga galvanized sheet metal unless otherwise noted.
- C. Steel sleeves, when required, shall be Schedule 40 carbon steel pipe with integral water stop.
- D. For core drilled holes, size and location shall be reviewed and approved by Structural Engineer prior to execution.
- E. Submit product data and installation details for penetrations of building structure. Submittal shall include schedule indicating penetrating materials, (including steel conduit, PVC conduit, cables, cable tray), sizes of each, opening sizes and sealant products intended for use.
- F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Division 26.
- G. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Drawings shall be approved by the structural engineer prior to preparing openings in structural member.
- H. Openings for penetrations shall be minimum 1/2" larger on all sides than outside dimensions of raceways or cables. However, where fire resistant penetrations are required, size openings in accordance with recommendations of firestopping systems manufacturer.
- I. Seal non fire-rated floor penetrations with non-shrink grout equal to Embecco by Master Builders, or urethane caulk, as appropriate.
- J. Seal non-rated wall openings with urethane caulk.

- K. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation, or sealing system by another manufacturer approved as equal by Architect. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.
- L. Finish and trim penetrations as shown on details and as specified hereinafter.
- M. Provide chrome or nickel plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor's closets, storage rooms, etc., unless suspended ceilings are specified.
- N. In **[GMP clean room] [Bio-safety] [Vivarium] [other]** areas, penetrations shall be sealed.
 - 1. Provide gasketed device cover plates with an additional continuous bead of silicone caulk between device plate and adjacent wall, ceiling or floor surface.
 - 2. Once wiring is installed, surround wiring with 1" barrier of silicone caulking around conductors within device box hub.
 - 3. Caulk shall be resistant to microbiological growth.

3.06 EQUIPMENT ACCESS

- A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocation of raceways, or accessories as required to provide access, shall be provided at no additional cost to Owner.
- B. Install equipment with ample space allowed for removal, repair or changes to equipment. Provide ready accessibility to equipment and wiring without moving other equipment, which is to be installed or which is already in place.
- C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors shall be for purpose of providing access where equipment requiring servicing, repairs or maintenance is located in walls, chases or above inaccessible ceilings.
- D. Provide necessary coordination and information to Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes and rough-in dimensions, without limitations.
- E. Provide access doors where equipment, requiring access for servicing, repairs and maintenance is located in walls, chases or above inaccessible ceilings, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Access doors used in fire-rated construction shall have UL label. Access doors shall be steel, prime coated, except use stainless steel doors in ceramic tile walls, toilet rooms, locker rooms, and in areas subject to excessive moisture. Access doors shall be of sufficient size to allow for total maintenance. Location of access doors shall be coordinated with General Contractor and location of equipment shall be roughed in accordingly.
- F. Locate communications outlets and equipment to fit details, panels, decorating or finish at space. Architect reserves right to make minor position changes of outlet locations before work has been installed.
- G. Verify room door swings before installing wall-mounted communications outlets and install boxes on latch side of door unless otherwise noted.

3.07 EQUIPMENT SUPPORTS

- A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers.
- B. Concrete anchors, used for attachment to concrete, shall be steel shell with plug type. Plastic, rawhide or anchors utilizing lead are not allowed.
- C. Do not support equipment or cable pathways from metal roof decking.

3.08 SUPPORT PROTECTION

- A. In occupied areas, mechanical rooms and areas requiring normal maintenance access, certain equipment must be guarded to protect personnel from injury.
- B. Provide minimum 1/2" thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.
- C. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

3.09 CABLE AND CONDUCTOR PROTECTION

- A. Protect cabling and termination components from contact with, and potential application of, foreign materials.
 - 1. Foreign material is defined as material that is not part of cabling assembly and termination components when delivered from manufacturer.
 - 2. Examples include paint overspray and drywall compound.
- B. Cabling and components that come into contact with foreign materials shall be replaced at no cost to project.
 - 1. Solvents and other cleaning agents shall not be used to remove foreign materials that have already accumulated on cabling and components.

3.010 HOUSEKEEPING PADS

- A. Not applicable to this Division of work.

3.011 LEAD SHIELDING

- A. Wherever installation of this Contractor's equipment destroys radiological integrity of wall, floor, or ceiling, this Contractor shall be responsible to provide suitable lead shielding to maintain that integrity. Coordinate these requirements with General Contractor.

3.012 INSTALLATION

- A. Pre-Installation Inspection
 - 1. Prior to commencement of work on site, Contractor shall inspect site to evaluate whether site conditions are sufficiently consistent with Contract Documents to support and facilitate execution of specified work and specified system performance.
 - 2. Contractor shall prepare and submit to Architect/Engineer and Owner report documenting observed inconsistencies that may impact execution of specified work or specified system performance. Report shall include photographs, annotated drawings, and written descriptions to clearly and completely document observed inconsistencies, and itemized recommendations and cost estimates for remediation of each observed inconsistency.
 - a. Contractor shall not take steps to remediate observed inconsistencies without written direction from Architect/Engineer and Owner.
 - 3. Commencement of work on site indicates Contractor's confirmation that existing conditions support and facilitate execution of specified work and specified system performance. Contractor shall be solely responsible for costs to remediate inconsistencies that went unreported prior to the Contractor's commencement of work on site.
- B. General
 - 1. Refer to manufacturer's product installation instructions, recommendations, and guidelines for additional information and requirements. If discrepancy is identified between Contract Documents and manufacturer's product installation instructions, more stringent requirement shall govern.
 - 2. Cable, devices, equipment, etc. shall not be installed until building is enclosed and weather tight, and temperature and humidity conditions are controlled continuously at levels approximately equivalent to final conditions expected after occupancy.

3. Cable, devices, equipment, etc. shall not be installed in areas where installed materials would be exposed to moisture, dust, overspray, or other deleterious conditions.
 4. No equipment, devices, cable, etc. shall be installed in Communications Equipment Rooms until room is broom clean and free of debris, dirt, dust, moisture, foreign materials, etc. and room is equipped with operable door that can be closed and latched to prevent ingress of deleterious conditions.
 5. Protect installed cable, devices, equipment, etc. from damage through completion of construction and date of Owner's final acceptance.
- C. Rough-In
1. Coordinate pathway requirements with Division 26 prior to commencement of work on site.
 2. Where Division 28 equipment or device is provided with equipment- or device-specific back box, Contractor shall provide back box to Division 26 prior to commencement of rough-in work on site.
 3. Unless noted otherwise, install conduit concealed in walls and ceilings. Exposed conduit in utility spaces and unfinished spaces is acceptable.
 4. Unless noted otherwise, install pathways and raceways parallel and perpendicular to major building orientation.
 5. Provide pathways and raceways complete with cable bend radius control fittings and accessories to maintain minimum bend radius of installed cables where cables transition into or out of and between sections of pathway or raceway.
 6. Unless noted otherwise, no flexible conduit of any type shall be used.
- D. Cable and Conductors
1. Cable shall be listed for installation in environment in which it is installed.
 - a. Cable installed in buried conduit, in-slab conduit where slab is poured on grade, or exterior or outdoor conduit or raceway shall be rated for outdoor installation.
 2. No cable or conductor shall be fished bare through interior of any enclosed, inaccessible ceiling, wall, or floor structures. Where such installation is required, fish flexible metallic conduit through structure, secure flexible metallic conduit at both ends, provide protective bushings at both ends, and install cable inside flexible metallic conduit.
 3. Install cabling in pathways provided, or as designated on floor plans, and support from building structure.
 4. Provide pull cord (200 lb minimum) with cable installed in conduit or innerduct.
 5. Cable and conductors installed shall be free of defects and damage. Provide required installation tools to facilitate cable and conductor installation without damaging cable and protect cable and conductors from damage. Visually inspect cable during installation for damage or defects, including cuts, blisters, and abrasions. Provide permanent abrasion protection at points where cable or conductors contact surface that could damage cable or conductors.
 6. Pull cable by hand unless installation conditions require mechanical assistance.
 7. Do not exceed recommended pulling tensions or bending radii during cable installation.
 - a. Where mechanical assistance is used, ensure that maximum tensile load for cable is not exceeded.
 - 1) This may be in form of continuous monitoring of pulling tension, use of "break-away" fitting, or other approved method.
 - b. Replace cables bent or kinked to radius less than recommended dimension.
 - 1) This shall be at no expense to Owner.
 8. Pulling lubricant may be used and shall:
 - a. Be non-injurious to cable jacket and other materials used.
 - b. Not harden or become adhesive with age.

9. Provide an adequate number of workers during cable and conductor pulling operations to observe cable or conductors at points of entry into and exit out of pathways, to feed cable and conductors, and to operate pulling machinery.
10. Cable and conductors shall be installed continuous and splice-free.
11. Installed cable and conductors shall be free of tension.
 - a. In cases where cable must bear stress, provide Kellems-type grips to distribute stress over greater length of cable.
12. Maintain manufacturer's published minimum bend radius on installed cable and conductors. Provide permanent bend radius protection at points where cable and conductors change direction.
13. Unless noted otherwise, install cable and conductors parallel and perpendicular to major building orientation.
14. Cable and conductors shall be kept clear of and protected from work by other trades.
15. No cable or conductor shall be attached to or supported in any manner by work by other trades.
16. No cable or conductor shall be laid on accessible ceiling grid or tiles, or attached or supported in any manner by accessible ceiling tiles, grid, or support wires.
17. In vertical pathway, support cables on each floor using industry recognized support methods designed specifically for that purpose.
 - a. Strap vertical runs as required to prevent sagging of cables.
18. Route and support cable in Equipment Rooms utilizing horizontal overhead cable runway, wall-mounted vertical cable runway, and wall-mounted "D-type" mounting rings.
19. Neatly lace, dress, and support cabling and conductors.
20. To reduce effects of EMI, adhere to the **[following]** minimum cable separation distances:**[**
 - a. **5" from power lines of 2 kVA**
 - b. **18" from high voltage lighting (including fluorescent and LED)**
 - 1) **When using LED lighting, stated separation distance shall be from cables to LED drivers.**
 - c. **39" from power lines of 5 kVA or greater**
 - d. **47" from transformers and motors]**
21. [Provide [6] [10] feet of cable slack at each device, coiled and stored neatly [on cable tray or last J-hook in the nearest accessible ceiling] [in last junction box] above the device.]
22. **[Provide [10] [20] feet of cable slack at head end equipment, coiled and stored neatly [on horizontal ladder rack] [on J-hooks] [in slack storage boxes] above the head end equipment.**

Coordinate surge suppression of devices mounted to the building and/or outside the building's lightning protection zone with the electrical engineer during the design phase, understanding that different device locations may require different surge suppression strategies.

23. Where cable serves exterior or outdoor equipment and devices located outside of the Lightning Protection Zone, provide surge suppression for each signal conductor in cable. Surge suppression device shall be bonded to an appropriate ground source in accordance with manufacturer's recommendations.
- E. Equipment and Device Termination
1. Install and tighten connectors per manufacturer's instructions, using appropriate tools recommended by manufacturer for that purpose. Do not strip or damage connectors, terminals, equipment or devices by over-tightening terminations.
 2. Unless noted otherwise, terminations for devices equipped with wire pigtail style connections shall be made only by irreversible means.

3. Cable and conductor color coding shall be maintained consistent throughout the installation for each equipment and device type.
 4. Provide minimum of **[12] [9] [6]** inches of slack at cable and conductor termination points.
 5. At exterior and outdoor equipment and devices not attached directly to the exterior of the building, provide surge suppression for each signal conductor.
- F. Equipment
1. Prior to ordering materials, coordinate final power requirements with Electrical Contractor for equipment and devices requiring power. Coordination shall include:
 - a. Voltage
 - b. Amperage
 - c. Connection type and plug configuration
 - d. Minimum and maximum allowable conductor sizes
 2. Prior to commencement of work on site, coordinate with General Contractor for structural, backing material, concrete embedments, etc. to support work under this Section.
 3. Unless noted otherwise, install wall mounted equipment in Equipment Rooms between +18" AFF and +72" AFF.
- G. Configuration and Programming
1. Coordinate configuration and programming with Owner prior to commencement of configuration and programming work.
 2. Coordinate Ethernet network requirements with Owner minimum of six weeks prior to commencement of programming work. Coordination shall include:
 - a. IP address
 - b. Subnet mask
 - c. Default gateway
 - d. TCP port numbers for active inbound and outbound connections
 - e. UDP port numbers for active inbound and outbound connections
 - f. VPN assignment
 - g. VLAN assignment
 - h. IP multicast functionality (yes/no)
 3. Change logins and passwords from manufacturer defaults upon first system startup, prior to commencement of configuration or programming work, and delete default accounts, logins, etc. that exist within manufacturer's standard software, firmware, configuration, programming, etc. Coordinate logins with Owner prior to commencement of configuration or programming work. At minimum, passwords used during execution of installation, configuration, programming, testing, commissioning, etc. work shall conform to Owner's in-house password requirements, conform to NIST SP 800-63B recommendations, and:
 - a. Shall consist of minimum of eight (8) printable ASCII characters
 - b. Shall not include repetitive or sequential characters, e.g. 'aaaaaa', '1234abcd', etc.
 - c. Shall not include context-specific words, e.g. name of service, username, derivatives thereof, etc.
 4. Configure servers, computers, IP-enabled equipment and devices, etc. to conform to Owner's in-house configuration, access, and security standards and requirements. Unless noted otherwise, configure servers, computers, IP-enabled equipment and devices, etc. to:
 - a. Use a VLAN dedicated solely to equipment and devices of system being supported and inaccessible from rest of Owner's Ethernet network.
 - b. Disable Universal Plug and Play (UPnP).
 - c. Be inaccessible from outside Owner's Ethernet network.
 - 1) Where connections to/from outside Owner's Ethernet network are specified, such connections shall use data protection, data validation, and endpoint verification.

- a) Digital Certificates shall be obtained from Certificate Authority recognized as valid in default internet browser software available from Microsoft, Google, Apple, and Mozilla.
- b) Self-signed Digital Certificates shall not be accepted.
- d. Be inaccessible from endpoints on Owner's Ethernet network not essential to system operation.
 - 1) Where connections to/from endpoints on Owner's Ethernet network not essential for system operation are specified, such connections shall use data protection, data validation, and endpoint verification.
 - a) Digital Certificates shall be obtained from Certificate Authority recognized as valid in default internet browser software available from Microsoft, Google, Apple, and Mozilla.
 - b) Self-signed Digital Certificates shall not be accepted.
 - e. Provide only minimal services required to support intended functions.
 - f. Close virtual ports not required to support intended functions.
 - g. Use IP address filtering to allow connections only to known devices that are part of same system.
 - h. Where devices are IEEE 802.1X capable, enable IEEE 802.1X port-based network access control.
 - i. Where devices are IPsec capable, enable IPsec packet encryption.
- 5. At no additional cost to Owner, apply manufacturer-issued operating system, software, firmware, etc. updates, patches, hotfixes, configuration updates, etc. to ensure operating system, software, firmware, configuration, etc. is current upon system turnover to Owner.
 - a. Prior to application, coordinate operating system updates, patches, hotfixes, etc. with Owner to ensure conformance to Owner's internal version standards.
- 6. Upon system turnover to Owner, change passwords to Owner-defined passwords. Coordinate passwords with Owner prior to system turnover.

3.013 INSPECTION AND TESTING

A. General

- 1. Submit with shop drawings documentation of proposed inspection and test procedures.
 - a. Inspection and testing shall not commence without Architect/Engineer's approval of proposed procedures. Commencement of inspection and testing without Architect/Engineer's approval of proposed procedures shall be grounds for Architect/Engineer and Owner to reject documentation of related inspection and testing and require repeat of related inspection and tests at no additional cost to Owner.
- 2. Prior to testing, visually inspect work to verify completion and compliance with applicable requirements.
- 3. Coordinate and schedule testing to be complete minimum of fifteen (15) working days prior to scheduled occupancy, such that Architect/Engineer and Owner have minimum of ten (10) working days to review draft test results and Owner has minimum of five (5) working days to prepare phase area for occupancy.
- 4. **[Coordinate and schedule testing phases to be complete minimum of fifteen (15) working days prior to scheduled occupancy of each construction phase, such that Architect/Engineer and Owner have a minimum of ten (10) working days to review draft test results and Owner has minimum of five (5) working days to prepare phase area for occupancy.]**
- 5. Conduct tests during course of construction when identifiable portion(s) of installation is complete.

- a. Alternatively, testing may be conducted after entire installation is complete, where doing so does not delay project schedule.
 6. Coordinate testing of work under this Division connected to or integrated with work under other sections with contractors of other trade(s) involved.
 7. Owner and/or Architect/Engineer may, at their option, be in attendance to witness testing. Submit proposed schedule for acceptance testing to Owner and Engineer minimum of ten (10) working days in advance to facilitate their participation.
 8. Provide equipment and personnel to conduct acceptance tests.
 9. Work shall be 100% fault free, unless otherwise noted. Where systems, equipment, devices, cable, etc. fail to meet required performance on criteria under test, replace or repair defective work and/or materials at no additional cost to Owner and repeat inspection and test. Replacement materials shall be new.
- B. Testing Cable
1. Test installed cable in accordance with applicable standards and cable manufacturer's and equipment manufacturer's published requirements, guidelines, and best practices.
 2. At minimum, testing of installed cable shall include:
 - a. Test for opens on each conductor
 - b. Test for conductor to conductor shorts, among all conductors
 - c. Test for conductor to ground shorts, for each conductor (where applicable)
 - d. Test for compliance with applicable cable performance standards (e.g., Category 3, Category 5e, Category 6, Category 6A, OS2, OM3, OM4, etc.)
 - 1) Refer to Section 27 1000 for additional information on and requirements for testing structured cabling.
 - e. Tests recommended by manufacturer of associated equipment or devices.
- C. Testing Devices
1. Verify proper operation of each feature and function of each device.
 2. Verify that each device has been configured and programmed in accordance with requirements of project documents and Owner's direction.
- D. Test Documentation
1. Document and certify test results in writing.
 2. Maintain copies of certified test results, including those for failed tests, at project site through completion of project.
- E. Re-Testing
1. Architect/Engineer or Owner may, at their option, request that a random 10% re-test be conducted by this Contractor at no additional cost to Owner to verify documented findings. Re-testing conducted shall be an exact repeat of those conducted and documented previously.
 2. Owner may, at their option, also perform independent re-testing to verify documented findings.
 3. If re-test findings contradict previous test documentation submitted by Contractor, additional re-testing shall be performed by this Contractor at no additional cost to Owner. The extent of such additional re-testing, including a 100% re-test, shall be determined solely by Architect/Engineer and Owner.

3.014 START-UP

- A. Systems and equipment shall be started, adjusted, tested, etc. and turned over to Owner ready for operation.
1. This includes "Owner-Furnished, Contractor-Installed" (OFICI) and "Contractor-Furnished, Contractor-Installed" (CFICI) systems and equipment.

- B. Provide services of manufacturer-trained and -certified technician who is knowledgeable in start-up, adjustment, and checkout of systems and equipment provided and is experienced with specific materials provided.
 - 1. Where Contractor does not employ such a technician directly on their own staff, Contractor shall provide at no additional cost to Owner such services from manufacturer's personnel.
- C. Where specified, provide at no additional cost to Owner, services of manufacturer's personnel for start-up, adjustment, and checkout of systems and equipment provided.
- D. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.
- E. Coordinate start-up with Owner and other trades.

3.015 DOCUMENTATION

- A. Upon completion of installation, Contractor shall provide System Documentation.
Documentation shall include:
 - 1. Acceptance Test Results
 - 2. Record Drawings
 - 3. All Approved Submittals
 - 4. Manufacturer's Warranty Documents
- B. Submit System Documentation in accordance with Division 01 "Project Record Documents".
 - 1. Documents shall be submitted in same electronic format in which they were received from Architect and Engineer.
 - 2. Document updates shall be performed in native software format matching original design team documents.
 - a. Scans of hand marked documents shall not be allowed.
 - 3. Update documents to reflect installed conditions for equipment shown on documents.
- C. Submit documentation within ten (10) working days of the completion of testing of each testing phase (e.g. subsystem, cable type, area, floor, etc.) or 3 weeks prior to scheduled occupancy of subject area, whichever is sooner. This is inclusive of Test Result and draft Record Drawings.
 - 1. Draft drawings may include mark-ups done by hand.
 - 2. Machine generated (final) copies of Record Drawings shall be submitted within 30 working days of completion of each testing phase.
 - 3. Documentation will include all aspects of systems covered by these specifications that are required for systems to be fully functional.
 - 4. For structured cabling this includes the horizontal link from the TO to the HC, backbone cabling from the HC to the MC, cross-connections, interconnections and/or patch cords that are the responsibility of the contractor.
- D. Submit Acceptance Test Results in electronic form for review and distribution.
 - 1. Interim documentation of Test Results (if applicable) may be submitted via email or on CD-ROM.
 - 2. Final documentation of Test Results shall be submitted on CD-ROM.
 - 3. Test results shall be submitted in format(s) native to test instrument(s) used in performing testing.
 - 4. Where unique software (other than an MS-Word™ compatible Word Processor or MS-Excel™ spreadsheet) is required for viewing of test results, Contractor shall provide along with above documentation, **[quantity]** licensed copy of such software. Software shall run on MICROSOFT Windows-based personal computer.
- E. Acceptance Test results shall include description of sub-system tested, equipment/cable/outlet I.D., reference and test setup, test equipment type/model and serial number(s), equipment location and direction of test (if applicable), test frequencies/wavelengths, date and operator name(s).

- F. Engineer or Owner may request that 10% random re-test be conducted on cable system - at no additional cost - to verify documented findings. Tests shall be a repeat of those defined above and in technical sections.
 - 1. Owner may also perform independent testing to verify results.
 - 2. If findings contradict documentation submitted by Contractor, additional testing can be requested to extent determined necessary by Engineer or Owner, including 100% re-test. This re-test shall be at no additional cost to Owner.
- G. Documentation - including hard copy and electronic forms of Test Data and Record Drawings - shall become property of Owner.
- H. Refer also to Technical Sections for requirements specific to covered subsystems.

3.016 CLEANING

- A. Refer to Division 01 for additional information and requirements.
- B. Refer to individual technical sections for additional information and requirements specific to work under that section.
- C. Contractor shall, periodically, throughout execution of work under this section and/or as directed by Architect/Engineer, Owner, Construction Manager, or General Contractor, remove waste materials, trash, rubbish, debris, etc. generated by execution of work under this section from building and leave work areas broom clean.
 - 1. Construction waste shall be managed in accordance with provisions of Division 01 Section Construction Waste Management.
- D. **[Prior to installation of active electronics, Electronic Safety and Security spaces must be cleaned to an ISO 14644-1 Class 8 standard.]**
- E. After installation is complete and prior to Owner's final acceptance, Contractor shall clean work provided under this section.
 - 1. Remove unused materials, tools, installation equipment, etc. from site.
 - 2. Faceplates, devices, components, equipment, enclosures, junction boxes, pull boxes, etc. shall be clean and free of stains, dust, dirt, debris, oil, grease, paint, and other foreign material.
 - 3. Interiors of equipment enclosures, junction boxes, pull boxes, etc. shall be clean and free of wire/cable scraps, pieces of wire/cable insulation, stains, dust, dirt, debris, oil, grease, paint, and other foreign material.
 - 4. Remove temporary labels not used for instruction or operation.
 - 5. Walls and floors of Electronic Safety and Security spaces and equipment rooms shall be clean and free of dust, dirt, debris, oil, grease, paint, and other foreign material.
 - 6. Remove and properly dispose of waste materials, trash, rubbish, debris, etc. generated by execution of work under this section.
 - 7. Contractor's cleaning protocol shall not damage provided materials or invalidate manufacturer's warranty on provided materials.
 - a. Contractor's cleaning protocol shall only include methods and use of solvents, chemicals, compounds, and agents approved by material manufacturer for use on their product.

3.017 [ATTIC STOCK]

- A. **Within [ten (10) business days] of [the date of substantial completion], deliver to [the Owner] at [the project site] spare equipment, devices, items, etc. specified in technical sections to be provided as Owner's Attic Stock.**
- B. **Refer to technical sections for Attic Stock device and equipment type and quantity requirements.**
- C. **Attic Stock materials provided shall match those installed and shall be new, in manufacturer's original, unopened packaging.**
- D. **Provide an inventory of Attic Stock materials, including:**

1. **Name of equipment, device, or item type, to match nomenclature used in Contract Documents**
2. **Brief description of equipment, device, or item**
3. **Manufacturer**
4. **Manufacturer's part number**
5. **Quantity installed per Contract Documents**
6. **Quantity provided as Owner's Attic Stock**
7. **Supplier information:**
 - a. **Name**
 - b. **Street address**
 - c. **Telephone number**
 - d. **Website address**
 - e. **Supplier's stock number, if different from Manufacturer's part number**

3.018 TRAINING

- A. Refer to Division 01 for additional information and requirements.
- B. Refer to technical sections for additional information and requirements specific to work under each section.
- C. Contractor shall train Owner's designated representative(s) on systems provided as part of work under this Division. Training shall include:
 1. System topology
 2. Equipment, devices, cable, etc. that constitute installed system
 3. Equipment Room layouts
 4. Location of equipment, devices, etc.
 5. Labeling scheme logic and label formats
 6. Core operating principles ("how it works")
 7. Features and functionality
 8. Startup process
 9. Operation
 10. Execution of tasks
 11. Commands
 12. Shut down process
 13. Restart and recovery process
 14. Care and maintenance, including:
 - a. Recommended tasks
 - b. Recommended schedule / intervals for each task
 - c. Step-by-step instructions for execution of each task
 - d. Items required to perform each task, including:
 - 1) Tools
 - 2) Parts
 - 3) Consumable materials (cleaners, lubricants, etc.)
 15. Troubleshooting, fault diagnosis, and remediation, including:
 - a. Common issues and malfunctions
 - b. Methods and execution of troubleshooting and fault diagnosis
 - c. Step-by-step instructions for execution of remediation:
 - d. Items required to perform remediation, including:
 - 1) Tools
 - 2) Parts
 - 3) Consumable materials (cleaners, lubricants, etc.)
 16. Contents of Operation and Maintenance Documents and Record Drawings

- D. Provide comprehensive manuals prepared to provide written version of specified instruction, and use these written manuals as reference materials during in-person verbal training sessions. Provide manuals in .pdf electronic form, and provide one (1) printed, bound copy of manuals for each Owner's designated representative attending in-person verbal training sessions, in addition to quantity specified to be provided as part of Operation and Maintenance Documents.
- E. In-person verbal training sessions shall include a walking tour component to observe actual work in facility and a "classroom" component based on written manuals.
- F. Coordinate training schedules with Owner and Architect/Engineer. No training session shall be scheduled with less than ten (10) business days' advance notification for attendees.
- G. Attendees shall include minimum of **[six (6)]** Owner's designated representatives.
- H. Training shall be held at **[Project Site]** and shall be conducted on Owner's standard days of operation during Owner's standard working hours.
- I. Owner may, at their option, videotape training session(s) for use as future refresher materials for Owner's staff.
- J. Refer to technical sections for minimum duration of in-person verbal training sessions specific to work under each section.

END OF SECTION

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Note:

The following is provided as an aid in understanding overall submittal requirements for Division 28 sections. Some sections and/or items may not apply. Contractor is responsible for submitting product data for all pertinent items specified in Division 28 Technical Sections include in project.

28 0545 - Electronic Safety and Security Integration

None Required

28 1000 - Electronic Access Control

Application Software	Division 28 Submittals
Application Interfaces	Division 28 Submittals
Server Hardware	Division 28 Submittals
Workstation Hardware	Division 28 Submittals
Ethernet Switches	Division 28 Submittals
Intelligent System Controllers	Division 28 Submittals
Credential Reader Interface Modules	Division 28 Submittals
Input Control Modules	Division 28 Submittals
Output Control Modules	Division 28 Submittals
Panel Enclosure	Division 28 Submittals
Power Supply	Division 28 Submittals
Credential Readers	Division 28 Submittals
Credentials	Division 28 Submittals
Electrified Locking Hardware	Division 28 Submittals
Latch Bolt Monitors	Division 28 Submittals
Door Position Monitors	Division 28 Submittals
Request to Exit Devices	Division 28 Submittals
Duress / Panic Button Control Panel	Division 28 Submittals
Duress / Panic Button	Division 28 Submittals
Cable	Division 28 Submittals
Raceways and Boxes	Division 28 Submittals
Surface Raceways	Division 28 Submittals

28 2000 Video Surveillance

Application Software	Division 28 Submittals
Server Hardware	Division 28 Submittals
Networked Video Storage	Division 28 Submittals
Workstation Hardware	Division 28 Submittals
Ethernet Switches	Division 28 Submittals
Cameras	Division 28 Submittals
Media Converters	Division 28 Submittals
Cable	Division 28 Submittals

Raceways and Boxes
Surface Raceways

Division 28 Submittals
Division 28 Submittals

28-3000 Intrusion Detection

Application Software
Application Interfaces

Division 28 Submittals
Division 28 Submittals
Division 28 Submittals
Division 28 Submittals
Division 28 Submittals

END

**SECTION 28 0545
ELECTRONIC SAFETY AND SECURITY SYSTEMS INTEGRATION**

PART 1 - GENERAL

1.01 SCOPE

- A. This section includes product and execution requirements for Electronic Safety and Security Systems Integration. Unless noted otherwise, work under this section is subject to requirements of Section 28 0000.

1.02 DESCRIPTION

- A. Refer to Section 280000 for additional information and requirements.
- B. Complete, turnkey Electronic Safety and Security Systems Integration compliant with applicable codes and standards referenced herein and as indicated on drawings.
- C. Electronic Safety and Security Systems Integration shall include the following major components:
 - 1. [~~list~~]
- D. **[Electronic Safety and Security Systems Integration shall be provided by Owner's incumbent vendor, [NAME OF OWNER'S INCUMBENT VENDOR], under subcontract to Contractor.**
 - 1. **[NAME OF OWNER'S INCUMBENT VENDOR]**
 - a. **Contact: [OWNER'S INCUMBENT VENDOR'S CONTACT'S FIRST AND LAST NAME]**
 - b. **Street Address: [OWNER'S INCUMBENT VENDOR'S ADDRESS]**
 - c. **Telephone: [OWNER'S INCUMBENT VENDOR'S CONTACT'S PHONE NUMBER, WITH AREA CODE]**
 - d. **Email: [OWNER'S INCUMBENT VENDOR'S CONTACT'S EMAIL ADDRESS]**

1.03 RELATED WORK

- A. Refer to Section 28 0000 for additional information and requirements.

1.1 REQUIREMENTS OF REGULATORY AGENCIES

- A. Refer to Section 28 0000 for additional information and requirements.

1.2 REFERENCES AND STANDARDS

- A. Refer to Section 28 0000 for additional information and requirements.

1.04 DEFINITIONS

- A. Refer to Section 28 0000 for additional information and requirements.

1.05 ABBREVIATIONS AND ACRONYMS

- A. Refer to Section 28 0000 for additional information and requirements.

1.06 LISTING

- A. Refer to Section 28 0000 for additional information and requirements.

1.07 SUBMITTALS

- A. Shop Drawings:
 - 1. Refer to Section 28 0000 for additional information and requirements.
 - 2. Submit an Electronic Safety and Security Systems Integration Schedule that documents details of each integration being provided, including:
 - a. Feature or function the integration provides
 - b. Systems being integrated
 - c. Power requirements
 - d. Communication requirements, including:
 - 1) Nature of physical connection(s) between systems being integrated

- 2) Converter and/or adapter hardware required to facilitate physical connections between systems being integrated
 - 3) Nature of logical connection(s) between systems being integrated
 - 4) Converter and/or adapter software required to facilitate logical connections between systems being integrated
 - 5) Custom software required to facilitate logical connections between systems being integrated, including the party in charge of developing the software
3. Submit sequence of operation for each integration being provided
- B. Certificates and Inspections
1. Refer to Section 28 0000 for additional information and requirements.
- C. Operation and Maintenance Manuals
1. Refer to Section 28 0000 for additional information and requirements.
- D. Record Documents
1. Refer to Section 28 0000 for additional information and requirements.

1.08 JOB CONDITIONS

- A. Refer to Section 28 0000 for additional information and requirements.

1.09 WORK BY OWNER

- A. Refer to Section 28 0000 for additional information.
- B. Owner will provide:
1. **[[Existing] Intrusion Detection system Server(s) [and Application Software]**
 2. **[[Existing] Intrusion Detection system Workstation(s) [and Application Software]]**
 3. **[[Existing] Ethernet Networking Electronics]**
 4. **[[Existing] Intrusion Detection Panel Enclosures, Intrusion Detection Power Supplies, Intelligent System Controllers, Credential Reader Interface Modules, Input Control Modules, and Output Control Modules]**

1.010 QUALITY ASSURANCE

- A. Refer to Section 28 0000 for additional information and requirements.

1.011 GUARANTEE

- A. Refer to Section 28 0000 for additional information and requirements.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Refer to Section 28 0000 for additional information and requirements.

2.02 <ADD DEVICES>

2.03 ELECTRONIC SAFETY AND SECURITY SYSTEMS INTEGRATION CABLE

- A. Refer to referenced technical Sections for requirements.

2.04 ELECTRONIC SAFETY AND SECURITY SYSTEMS INTEGRATION HANGERS AND SUPPORTS

- A. Refer to referenced technical Sections for requirements.

2.05 ELECTRONIC SAFETY AND SECURITY SYSTEMS INTEGRATION RACEWAYS AND BOXES

- A. Refer to referenced technical Sections for requirements.

2.06 ELECTRONIC SAFETY AND SECURITY SYSTEMS INTEGRATION SURFACE RACEWAYS

- A. Refer to referenced technical Sections for requirements.

PART 3 - EXECUTION

3.01 PRE-CONSTRUCTION COORDINATION MEETING

- A. Prior to preparing and submitting shop drawings, Contractor shall arrange and conduct a pre-construction coordination meeting to review and coordinate Electronic Safety and Security Systems Integration requirements.
1. Attendees shall include:
 - a. Owner's project manager, security representative, and facilities / buildings and grounds / maintenance representative
 - b. Division 28 Engineer
 - c. Construction Manager / General Contractor project manager and site superintendent / field foreman
 - d. Division 28 project manager and site superintendent / field foreman
 - e. Electronic Access Control subcontractor/supplier project manager and system programmer
 - f. Video Surveillance subcontractor/supplier project manager and system programmer
 - g. Intercom subcontractor/supplier project manager and system programmer
 - h. Intrusion Detection subcontractor/supplier project manager and system programmer
 - i. **[LIST OTHER REQUIRED ATTENDEES PER INTEGRATIONS SPECIFIED]**
 2. Meeting agenda topics shall include:
 - a. Review and coordinate details of each integration being provided, including:
 - 1) Feature or function the integration provides
 - 2) Systems being integrated
 - 3) Nature of physical connection(s) between systems being integrated
 - 4) Converter and/or adapter hardware required to facilitate physical connections between systems being integrated
 - 5) Nature of logical connection(s) between systems being integrated
 - 6) Converter and/or adapter software required to facilitate logical connections between systems being integrated
 - 7) Custom software required to facilitate logical connections between systems being integrated, including the party in charge of developing the software
 - 8) Intended operation
 - b. Coordinate division of work among trades.
 - c. Review construction schedule and identify milestones related to Electronic Safety and Security Systems Integration
 3. Schedule meeting with minimum two weeks' notice.
 - a. Publish agenda for meeting and distribute to invited attendees when meeting is scheduled.
 4. Take detailed notes during meeting and publish meeting minutes within one week after meeting. Distribute minutes to invited attendees and Architect.

3.02 PRE-INSTALLATION COORDINATION MEETING

- A. After Section 28 0545 shop drawings have been approved, Contractor shall arrange and conduct a pre-installation coordination meeting to review and coordinate furnishing and installation of equipment and devices related to Electronic Safety and Security Systems Integration.
1. Attendees shall include:
 - a. Construction Manager / General Contractor project manager and site superintendent / field foreman
 - b. Division 26 project manager and site superintendent / field foreman
 - c. Division 27 project manager and site superintendent / field foreman
 - d. Division 28 project manager and site superintendent / field foreman

- e. Electronic Access Control subcontractor/supplier project manager and system programmer
 - f. Video Surveillance subcontractor/supplier project manager and system programmer
 - g. Intercom subcontractor/supplier project manager and system programmer
 - h. Intrusion Detection subcontractor/supplier project manager and system programmer
 - i. **[LIST OTHER REQUIRED ATTENDEES PER INTEGRATIONS SPECIFIED]**
2. Meeting agenda topics shall include:
- a. Review and coordinate details of furnishing and installing equipment and devices related to each integration, including:
 - 1) Systems being integrated
 - 2) Requirements for each item of equipment or device involved in the integration:
 - a) Location
 - b) Power
 - c) Communication, including:
 - a Nature of physical connection(s) between systems being integrated
 - b Converter and/or adapter hardware required to facilitate physical connections between systems being integrated
 - c Nature of logical connection(s) between systems being integrated
 - d Converter and/or adapter software required to facilitate logical connections between systems being integrated
 - e Custom software required to facilitate logical connections between systems being integrated, including the party in charge of developing the software
 - d) Mounting
 - e) Box and conduit rough-in
 - b. Coordinate testing and adjustment of each integration and related equipment and devices.
 - c. Coordinate division of work among trades.
 - d. Review overall construction schedule and installation, configuration, programming, and testing schedule, and coordinate inter-trade schedule interdependencies.
3. Hold meeting minimum two weeks prior to commencement of rough-in work on site.
4. Schedule meeting with minimum two weeks' notice.
- a. Publish agenda for meeting and distribute to invited attendees when meeting is scheduled.
5. Take detailed notes during meeting and publish meeting minutes within one week after meeting. Distribute minutes to invited attendees, Architect, and Engineer.

3.03 CONFIGURATION AND PROGRAMMING COORDINATION MEETING

- A. After Section 28 0545 shop drawings have been approved, Contractor shall arrange and conduct a configuration and programming coordination meeting to review and coordinate Electronic Safety and Security Systems Integration device and equipment configuration and programming.
1. Attendees shall include:
- a. Owner's project manager, security representative, and facilities / buildings and grounds / maintenance representative
 - b. Construction Manager / General Contractor project manager and site superintendent / field foreman
 - c. Division 28 project manager and site superintendent / field foreman

- d. Electronic Access Control subcontractor/supplier project manager and system programmer
 - e. Video Surveillance subcontractor/supplier project manager and system programmer
 - f. Intercom subcontractor/supplier project manager and system programmer
 - g. Intrusion Detection subcontractor/supplier project manager and system programmer
 - h. **[LIST OTHER REQUIRED ATTENDEES PER INTEGRATIONS SPECIFIED]**
2. Meeting agenda topics shall include:
- a. Review and coordinate details of each integration being provided, including:
 - 1) Feature or function the integration provides
 - 2) Systems being integrated
 - 3) Sequence of operation
 - 4) Review of product-specific configuration and programming guide detailing configuration and programming options applicable to system software, hardware, equipment, and devices being integrated
 - 5) Configuration and programming of system server(s) and workstations and of server/workstation graphical user interface screens related to the integration
 - b. Coordinate division of work among trades.
 - c. Review overall construction schedule and installation, configuration, programming, and testing schedule, and coordinate inter-trade schedule interdependencies.
3. Hold meeting minimum four weeks prior to commencement of configuration and programming work.
4. Schedule meeting with minimum two weeks' notice.
- a. Publish agenda for meeting and distribute to invited attendees when meeting is scheduled.
5. Take detailed notes during meeting and publish meeting minutes within one week after meeting. Distribute minutes to invited attendees, Architect, and Engineer.

3.04 GENERAL

- A. Refer to Section 28 0000 for additional information and requirements.

3.05 INSTALLATION

- A. General

1. [Integrate new work under this project in to Owner's existing system.]

B. Integrations

1. Elevator

- a. Contractor shall provide required cabling for security peripherals shown on project documents. Contractor shall also provide additional material and labor necessary to facilitate system operation.
- b. Contractor shall provide elevator interface as shown on drawings. Interface shall include provisions to support alarm monitoring and authorize access to select floors.
- c. Contractor shall furnish security peripherals to Elevator Contractor for installation within elevator systems or cab. Only Elevator Contractor shall alter, install, or make modification to elevator return panel or interior finished areas within elevator cab.
 - 1) Elevator Contractor shall provide elevator control equipment and required elevator system programming and wiring from card readers in elevator cab and at elevator lobbies to elevator machine room.
- d. Contractor shall extend security peripheral cabling located in redirect panel for final connection by Elevator Contractor.

- 1) Contractor shall provide redirect panel in break out box in elevator machine room.
- 2) Contractor shall provide connection to provide access control functionality in select elevator cabs within this break out box.
- 3) Breakout box shall be alarmed and key lockable.
- 4) Contractor shall coordinate elevator recall. If allowed by code, elevator recall for a non-fire event shall recall elevator off accessible public floors to secure floor.

e. Operation

- 1) ACMS operation shall be coordinated with Owner. Contractor shall configure manual or automatic initiation of secure and non-secure operation modes for elevator cabs equipped with access control readers.
- 2) Interface between elevator system and ACMS shall be disengaged upon activation of elevator service mode, allowing access to any floor without authorized credential presentation.
 - a) Contractor shall provide output to ACMS system to denote when elevator service mode has been activated. This input shall annunciate on the ACMS host server as an alarm input.
- 3) If no floor button is selected after authorized credential presentation, security system shall reset and deactivate all buttons until next authorized credential is presented.
 - a) Acceptable button selection time period will be defined by Owner.
- 4) Upon valid credential presentation and after desired floor has been selected, elevator system shall illuminate only the floor selected.
 - a) ACMS and elevator system shall not allow more than one button selection per valid credential presentation to reader inside cab.

2. Fire Alarm Interface

- a. Door hardware power supplies shall be capable of receiving relay input from fire alarm system, as required by code.
 - 1) Relay input shall be solely utilized for deactivation (unlocking) of access-controlled doors within a path of egress upon initiating signal from the fire alarm system.
- b. Refer to Division 26 drawings for fire alarm panel locations and UL-listed fire interface connection points.
 - 1) Contractor shall provide required cable and conduit for connection to fire interfaces for egress path doors.

3. Operator

- a. Roll-Up/Sliding Doors/Gate Operators
 - 1) Contractor shall provide interface with roll-up door operators.
 - 2) Door control shall provide direct interface with ACMS credential holder database, allowing authorized credential holders to activate roll-up doors through use of a credential reader or remote operation.
 - 3) ACMS shall also have capability of opening, holding, and closing roll-up doors through on-screen icons and commands generated from ACMS GUI.
 - 4) Roll-up door operator safety features shall be preserved and ACMS shall not interfere with safety or operation of roll-up door.
- b. Optical beam/Passive Infra-Red (PIR)
 - 1) Provide optical beam devices/reflectors as shown on details to facilitate select operation of doors equipped with extended range reader.
- c. Accessible Door Operators

- 1) Contractor shall provide interface for controlling doors equipped with accessible door operators. Following conditions shall be met and shall be provided by Contractor:
 - a) Accessible door operators shall not be functional until presentation of approved credential. Credential shall enable accessible door operator push pad, which shall energize door operator.
 - 2) Following pre-set time period coordinated with Contractor, automatic door opening device shall release and door shall close and re-lock.
 - 3) Contractor shall provide interfaces to allow exiting from doors equipped with door operators and electrified hardware controlled by ACMS.
 - a) Contractor shall provide connection to door operator or third-party request-to-exit sensor to de-energize or energize associated door hardware prior to activation of door operator.
 4. Operable Revolving Doors
 - a. Provide relay inputs and outputs to grant access, lock, and obtain generated alarms from revolving doors (e.g. Piggy-backing, door collapse, door monitoring).
 5. Magnetic hold-open(s)
 - a. Contractor, at select doors, shall provide relay to remotely de-energize magnetic hold-open devices to allow doors to close. Refer to drawings for locations.
 6. Intercom
 - a. Provide interface with intercom, so that relays activated by VCS system shunt associated door position switch for ACMS.
 7. Video intercom
 - a. Provide interface video intercom, so that relays activated by the VCS system shunt associated door position switch for ACMS.
 8. Biometric Devices
 - a. Contractor shall ensure that ACMS seamlessly interfaces with biometric devices being proposed.
 - b. Interface shall support native integration for credential-holder enrollment, and separate enrollment workstation, system, or software shall not be required.
 9. Medical Imaging Equipment Door Interlocks
 - a.
- C. System Servers and Application Software
1. Coordinate exact location with Owner and work by other trades prior to installation.
 2. Coordinate schedule for activating power with on-site Division 26 Contractor prior to the commencement of work on site.
 3. Properly ground system servers with minimum 6 AWG bonding conductor terminated with two-hole compression lugs. Refer to Section 270526 for additional information and requirements.
 4. Provide surge protective device in-line just before connection to electrical receptacle.
 5. Provide surge protective device in-line just before connection to Ethernet jack.
 6. Coordinate configuration of server operating system software with Owner and with system application software manufacturer prior to installation and configuration.
 7. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
- D. System Workstations and Application Software
1. Coordinate exact location with Owner and work by other trades prior to rough-in.
 2. Coordinate power requirements, connection locations, and schedule for activating power with on-site Division 26 Contractor prior to the commencement of work on site.
 3. Provide surge protective device in-line just before connection to electrical receptacle.
 4. Provide surge protective device in-line just before connection to Ethernet jack.

5. Coordinate configuration of workstation operating system software with Owner and with system application software manufacturer prior to installation and configuration.
6. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
- E. Electronic Safety and Security Systems Integration Cable
 1. Refer to referenced technical Sections for requirements.
- F. Electronic Safety and Security Systems Integration Hangers and Supports
 1. Refer to referenced technical Sections for requirements.
- G. Electronic Safety and Security Systems Integration Raceways and Boxes
 1. Refer to referenced technical Sections for requirements.
- H. Electronic Safety and Security Systems Integration Surface Raceways
 1. Refer to referenced technical Sections for requirements.
- I. Configuration and Programming
 1. Coordinate IP address requirements with Owner a minimum of six weeks prior to commencement of programming work.

3.06 INSPECTION AND TESTING

- A. After successful completion of testing and prior to final acceptance, verify final operation of each integration on site with Owner.
- B. Verification Follow-Up Visits
 1. Contractor shall include in their bid a minimum of two (2) unique visits to site to review operation of each integration on site with Owner.
 2. Schedule:
 - a. First visit will occur within six (6) months of substantial completion or at Owner's request, whichever comes first.
 - b. Second visit will occur within twelve (12) months of substantial completion or at Owner's request, whichever comes first.
 - c. Tentatively coordinate schedule for both visits upon substantial completion of work on site, but before final acceptance of the project.
 3. Provide for average of fifteen (15) minutes per instance of each integration provided under this project or total of eight (8) hours on site for each visit, whichever is greater.
 4. After each visit, prepare a report detailing observation of operation of each instance of each integration provided, discussion with Owner about each instance of each integration provided, and adjustments made.
 5. Contractor's bid shall include all labor costs associated with visits, including:
 - a. Off-site pre-preparation time
 - b. On-site time
 - c. Travel time
 - d. Off-site report preparation time

3.07 START-UP

- A. Refer to Section 28 0000 for additional information and requirements.

3.08 DOCUMENTATION

- A. Refer to Section 28 0000 for additional information and requirements.

3.09 CLEANING

- A. Refer to Section 28 0000 for additional information and requirements.

3.010 [ATTIC STOCK]

- A. **Refer to Section 280000 for additional information and requirements.**
- B. **Provide the following spare devices and equipment as Owner's attic stock:**
 1. **[Surge Suppressors: 100% of the quantity installed of each type provided.]**

2. **[Fuses: 20% of each type provided as part of system devices and equipment, minimum ten (10) of each type provided.]**

3.011 TRAINING

- A. Refer to Section 28 0000 for additional information and requirements.
- B. Contractor shall provide to Owner's designated representative(s) a minimum of **[one (1)] [two (2)] [1-hour] [4-hour] [8-hour]** on-site training **session[s]** related to work under this section within fifteen (15) **[thirty (30)] [seven (7)]** days of substantial completion.

END OF SECTION

**SECTION 28 1000
ELECTRONIC ACCESS CONTROL**

PART 1 - GENERAL

1.01 SCOPE

- A. This section includes product and execution requirements for Electronic Access Control. Unless noted otherwise, work under this section is subject to requirements of Section 28 0000.

1.02 DESCRIPTION

- A. Refer to Section 280000 for additional information and requirements.
- B. Complete, turnkey Electronic Access Control system compliant with applicable codes and standards referenced herein and as indicated on drawings.
- C. The Electronic Access Control system shall include the following major components:
1. **[Electronic Access Control System Application Software]**
 2. **[Electronic Access Control System Server(s)]**
 3. **[Electronic Access Control System Workstation(s)]**
 4. **[Intelligent System Controllers]**
 5. **[Credential Reader Interface Modules]**
 6. **[Input Control Modules]**
 7. **[Output Control Modules]**
 8. **[Electronic Access Control Panel Enclosure]**
 9. **[Electronic Access Control Power Supply]**
 10. **[Credential Readers]**
 11. **[Credentials]**
 12. **[Electrified Door Locking Hardware]**
 13. **[Latch Bolt Monitors]**
 14. **[Door Position Monitors]**
 15. **[Request to Exit Devices]**
 16. **[Remote Door Release Button]**
 17. **[Local Annunciators]**
 18. **[Tamper Monitor]**
 19. **[Digital Alarm Communicator Transmitter]**
 20. **[Duress/Panic Button]**
 21. **[Electronic Access Control Cable]**
 22. **[Electronic Access Control Raceways and Boxes]**
 23. **[Electronic Access Control Surface Raceways]**
- D. **[Electronic Access Control shall be provided by Owner's incumbent vendor, [NAME OF OWNER'S INCUMBENT VENDOR], under subcontract to Contractor.**
1. **[BUSINESS NAME OF OWNER'S INCUMBENT VENDOR]**
 - a. **Contact: [OWNER'S INCUMBENT VENDOR'S CONTACT'S FIRST AND LAST NAME]**
 - b. **Street Address: [OWNER'S INCUMBENT VENDOR'S ADDRESS]**
 - c. **Telephone: [OWNER'S INCUMBENT VENDOR'S CONTACT'S PHONE NUMBER, WITH AREA CODE]**
 - d. **Email: [OWNER'S INCUMBENT VENDOR'S CONTACT'S EMAIL ADDRESS]**

1.03 RELATED WORK

- A. Refer to Section 28 0000 for additional information and requirements.

1.1 REQUIREMENTS OF REGULATORY AGENCIES

- A. Refer to Section 28 0000 for additional information and requirements.

- A. **[Contractor is solely responsible for securing [NAME OF REVIEWING / PERMITTING AGENCY OR ENTITY] Work Permit for Electronic Access Control prior to the commencement of work on site.**
 - 1. **Contractor shall prepare and submit Work Permit application submittal documents and forms.**
 - 2. **Contractor shall include in their bid costs, charges, fees, taxes, etc. associated with securing Work Permit]**

1.2 REFERENCES AND STANDARDS

- A. Refer to Section 28 0000 for additional information and requirements.

1.04 DEFINITIONS

- A. Refer to Section 28 0000 for additional information and requirements.

1.05 ABBREVIATIONS AND ACRONYMS

- A. Refer to Section 28 0000 for additional information and requirements.

1.06 LISTING

- A. Refer to Section 28 0000 for additional information and requirements.

1.07 SUBMITTALS

- A. Shop Drawings:
 - 1. Refer to Section 28 0000 for additional information and requirements.
 - 2. Submit Contractor-prepared Electronic Access Control Schedule that documents for each controlled and/or monitored portal each Electronic Access Control device, connection, function, and integration listed in Division 08 Door Schedule and Division 08 Door Hardware Group, specified herein and on drawings, and per Contractor coordination with Owner, to include:
 - a. Door Number
 - b. Room Name
 - c. Plan Reference
 - d. Door Hardware Group
 - e. Electronic Access Control devices and connections
 - f. Functionality features
 - g. Integrations
- B. Certificates and Inspections
 - 1. Refer to Section 28 0000 for additional information and requirements.
- C. Operation and Maintenance Manuals
 - 1. Refer to Section 28 0000 for additional information and requirements.
- D. Record Documents
 - 1. Refer to Section 28 0000 for additional information and requirements.

1.08 JOB CONDITIONS

- A. Refer to Section 28 0000 for additional information and requirements.

1.09 WORK BY OWNER

- A. Refer to Section 28 0000 for additional information.
- B. Owner will provide:
 - 1. **[[Existing] Electronic Access Control system Server(s) [and server Application Software]**
 - a. **[List name of existing Electronic Access Control system server and application software]**
 - 2. **[[Existing] Electronic Access Control system Workstation(s) [and workstation Application Software]]**

3. **[[Existing] Ethernet Networking Electronics]**
4. **[[Existing] Electronic Access Control Panel Enclosures, Electronic Access Control Power Supplies, Intelligent System Controllers, Credential Reader Interface Modules, Input Control Modules, and Output Control Modules]**
5. **[Electronic Access Control credentials]**

1.010 QUALITY ASSURANCE

- A. Refer to Section 28 0000 for additional information and requirements.

1.011 GUARANTEE

- A. Refer to Section 28 0000 for additional information and requirements.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Refer to Section 28 0000 for additional information and requirements.
- B. Unless noted otherwise, the following equipment and devices shall be the products of a single manufacturer and designed, manufactured, marketed, sold, and supported as an integrated system:
 1. **[Electronic Access Control System Application Software]**
 2. **[Intelligent System Controllers]**
 3. **[Credential Reader Interface Modules]**
 4. **[Input Control Modules]**
 5. **[Output Control Modules]**
 6. **[Electronic Access Control Panel Enclosure]**
 7. **[Electronic Access Control Power Supply]**
 8. **[Credential Readers]**
 9. **[Credentials]**

2.02 ELECTRONIC ACCESS CONTROL SYSTEM APPLICATION SOFTWARE

- A. Features
 1. Certified for use with Windows 10 and Windows Server 2019
 2. Communicates with Intelligent System Controllers via TCP/IP Ethernet
 3. Application Module
 - a. Interfaces with [Electronic Access Control System Workstations], [Electronic Access Control System Badging Stations], Intelligent System Controllers, **[Biometric Readers]**, and other Electronic Access Control System equipment and devices
 - b. Interfaces with **[Intrusion Detection Control Panels]**, **[Video Surveillance Network Video Management Systems]**, **[Video Door Intercom Systems]**, and other building systems at the software level
 - c. Organizes, stores, and manages Electronic Access Control System data on a single SQL database
 - d. Supports Microsoft Windows Clustering, Hot-Standby, Fault Tolerant Servers, and Fault Tolerant Hot Standby Servers
 - e. Interfaces bi-directionally with external data sources using:
 - 1) ASCII with support for manual and automatic XML formatted text exchange of data
 - 2) ASCII with support for manual and automatic XML formatted text exchange of data, via direct table interface
 - 3) API-based real-time exchange of data via Active Directory/LDAP. The live exchange of data shall permit exposure of SMS events and transactions to other data sources in real time and allow for receipt of data into the SMS

permitting this data to be acted upon and trigger linked events in the SMS in real time.

4) IBM WebSphere adapter based real-time exchange of information.

4. Operator / Graphical User Interface Module

a.

5. Credential Design Module

a.

6. Credential Management Module

a.

7. **[Visitor Management Module]**

a.

8. <more>

B. Specifications

1. <SPECIFICATIONS>

C. Basis of Design:

1. Lenel OnGuard

D. Acceptable Alternates:

1. AMAG Symmetry

2. Andover Continuum

3. Genetec Synergis

4. Identiv Hirsch Velocity

5. Open Options DNA Fusion

6. RS2 Access It

7. TYCO Software House C-Cure

E. Provide complete with licenses for new work specified in Contract Documents and to provide functionality and integrations specified in Contract Documents.

2.03 ELECTRONIC ACCESS CONTROL SYSTEM SERVER HARDWARE

A. Features

1. Rack mount configuration

2. Dual redundant hot-swappable power supplies

3. <more>

4. **[Windows Server 2019] [Windows 10]** operating system

B. Specifications

1. <SPECIFICATIONS>

C. Basis of Design:

1. Lenovo

D. Acceptable Alternates:

1. Dell

2. Hewlett-Packard

A. Provide complete with:

1. Software applications and licenses for new work specified in Contract Documents and to provide functionality and integrations specified in Contract Documents.

2. Rack Mount Console Drawer:

a. Configuration: Rack mount, 1 RU

b. Video Display Monitor:

1). Nominal Size: 17" diagonal

2). Resolution: 3840x2160

3). Input: HDMI

c. Wired USB Keyboard with touch pad

2.04 ELECTRONIC ACCESS CONTROL SYSTEM WORKSTATION HARDWARE

- A. Features
 - 1. Desktop tower configuration
 - 2. <more>
 - 3. Windows 10 operating system
- B. Specifications
 - 1. <SPECIFICATIONS>
- C. Basis of Design:
 - 1. Lenovo
- D. Acceptable Alternates:
 - 1. Dell
 - 2. Hewlett-Packard
- E. Provide complete with:
 - 1. Software applications and licenses for new work specified in Contract Documents and to provide functionality and integrations specified in Contract Documents.
 - 2. Video Display Monitor:
 - a. Configuration: Free-standing desktop
 - b. Nominal Size: 24" diagonal
 - c. Resolution: 3840x2160
 - d. Input: HDMI
 - 3. Wired USB Keyboard
 - 4. Wired USB optical mouse
 - 5. Uninterruptible Power Supply
 - a. Configuration: Tower
 - b. Type: Line Interactive
 - c. Input Voltage: 120 Volts AC
 - d. Output Voltage: 120 Volts AC
 - e. Capacity: 1500 VA
 - f. Efficiency: $\geq 90\%$
 - g. Transfer Time, Typical: 6 milliseconds
 - h. Surge Energy Rating: ≥ 300 Joules

2.05 ELECTRONIC ACCESS CONTROL SYSTEM BADGING STATION HARDWARE

- A. Badging Station Workstation Hardware
 - 1. Features
 - a. Desktop tower configuration
 - b. <more>
 - c. Windows 10 operating system
 - 2. Specifications
 - a. <SPECIFICATIONS>
 - 3. Basis of Design:
 - a. Lenovo
 - 4. Acceptable Alternates:
 - a. Dell
 - b. Hewlett-Packard
 - 5. Provide complete with:
 - a. Software applications and licenses for new work specified in Contract Documents and to provide functionality and integrations specified in Contract Documents.
 - b. Video Display Monitor:
 - 1) Configuration: Free-standing desktop

- 2) Nominal Size: 24" diagonal
- 3) Resolution: 3840x2160
- 4) Input: HDMI
- c. Wired USB Keyboard
- d. Wired USB optical mouse
- 6. Uninterruptible Power Supply
 - a. Configuration: Tower
 - b. Type: Line Interactive
 - c. Input Voltage: 120 Volts AC
 - d. Output Voltage: 120 Volts AC
 - e. Capacity: 1500 VA
 - f. Efficiency: $\geq 90\%$
 - g. Transfer Time, Typical: 6 milliseconds
 - h. Surge Energy Rating: ≥ 300 Joules
- B. Badging Station Camera
 - 1. Features
 - a. <FEATURES>
 - 2. Specifications
 - a. <SPECIFICATIONS>
 - 3. Basis of Design:
 - a. <BASIS OF DESIGN>
 - 4. Acceptable Alternates:
 - a. <ACCEPTABLE ALTERNATE ONE>
 - b. <ACCEPTABLE ALTERNATE TWO>
- C. Badging Station Badge Printer
 - 1. Features
 - a. <FEATURES>
 - 2. Specifications
 - a. <SPECIFICATIONS>
 - 3. Basis of Design:
 - a. <BASIS OF DESIGN>
 - 4. Acceptable Alternates:
 - a. <ACCEPTABLE ALTERNATE ONE>
 - b. <ACCEPTABLE ALTERNATE TWO>

2.06 ETHERNET SWITCHES

- A. Features
 - 1. <FEATURES>
- B. Specifications
 - 1. <SPECIFICATIONS>
- C. Basis of Design:
 - 1. Cisco
- D. Acceptable Alternates:
 - 1. Juniper
 - 2. Hewlett-Packard
- A. Provide complete with licenses for new work specified in Contract Documents and to provide functionality and integrations specified in Contract Documents.

2.07 INTELLIGENT SYSTEM CONTROLLERS

- A. Features:
 - 1. Compatible with Electronic Access Control System Application Software

2. Supports up to 16 credential readers, 160 input points, and 144 output points
 3. Supports Wiegand credential reader communication
 4. Supports proximity and SMART credential technology
 5. Onboard configuration backup
 6. Nonvolatile memory for operating system, configuration data, and operations data storage and backup
 7. Programmable via Ethernet or RS-232
 8. UL listed
- B. Specifications:**
1. Host Communications: Ethernet via RJ-45 connector
 2. Accessory Module Communications: RS-485 via terminal strip connector
 3. Input Power Requirements: 1 amp at 12 volts DC
 4. Operating Temperature (Environmental): 32°F - 122°F
- C. Basis of Design:**
1. Mercury LP2500
- D. Acceptable Alternates:**
1. AMAG Symmetry M4000
 2. Andover Continuum ACX 57 series
 3. Identiv Hirsch Mx series
 4. Lenel OnGuard LNL-X3300
 5. Open Options SSP-EP
 6. RS2 SCP
 7. TYCO Software House iStar Pro

2.08 CREDENTIAL READER INTERFACE MODULES

- A. Features:**
1. Supports one electronic access control door, each with:
 - a. Up to two credential readers
 - 1) Includes connections for reader power, reader data, red lamp, green lamp
 - b. Two supervised inputs per leaf
 - c. Two outputs
 2. Supports Wiegand credential reader communication
 3. Supports proximity and SMART credential technology
 4. UL listed
- B. Specifications:**
1. Controller Communications: RS-485 via terminal strip connector
 2. Input Power Requirements: 2 amps at 12 volts DC
 3. Reader Power Output: ≤ 250 milliamps at 12 volts DC
 4. Reader LED Power Output: ≤ 100 milliamps at 12 volts DC
 5. Relay Output Rating: ≤ 1 amp at 12-24 volts DC
 6. Connections: Terminal strip
 7. Operating Temperature (Environmental): 32°F - 122°F
- C. Basis of Design:**
1. Mercury MR50 / MR52
- D. Acceptable Alternates:**
1. AMAG DEC4
 2. Andover xPBD4
 3. Identiv Hirsch RREB
 4. Lenel OnGuard LNL-1300 / LNL-1320
 5. Open Options RSC-1 / RSC-2

6. RS2 MR-50 / MR-52
7. TYCO Software House iStar RM-4

2.09 INPUT CONTROL MODULES

A. Features:

1. Supports eight Class A supervised inputs
2. UL listed

B. Specifications:

1. Controller Communications: RS-485 via terminal strip connector
2. Input Power Requirements: 180 milliamps at 12 volts DC
3. Connections: Terminal strip
4. Operating Temperature (Environmental): 32°F - 122°F

C. Basis of Design:

1. Mercury MR16IN

D. Acceptable Alternates:

1. AMAG IOC20/16
2. Andover xPBD4
3. Identiv Hirsch AEB8
4. Lenel OnGuard LNL-1100
5. Open Options ISC-16
6. RS2 MR-16IN
7. TYCO Software House iStar I8-CSI

2.010 OUTPUT CONTROL MODULES

A. Features:

1. Supports eight Form C dry contact relay outputs
2. UL listed

B. Specifications:

1. Controller Communications: RS-485 via terminal strip connector
2. Input Power Requirements: 300 milliamps at 12 volts DC
3. Relay Output Rating: ≤ 2 amps at 30 volts DC resistive, ≤ 1 amps at 30 volts DC inductive, ≤ 400 milliamps at 125 volts AC
4. Connections: Terminal strip
5. Operating Temperature (Environmental): 32°F - 122°F

C. Basis of Design:

1. Mercury MR16OUT

D. Acceptable Alternates:

1. AMAG IOC20/16
2. Andover xPBD4
3. Identiv Hirsch REB8
4. Lenel OnGuard LNL-1200
5. Open Options OSC-16
6. RS2 MR-16OUT
7. TYCO Software House iStar R8

2.011 ELECTRONIC ACCESS CONTROL PANEL ENCLOSURE

A. Features:

1. Wall mount
2. Steel enclosure with powder coat finish and lockable hinged door
3. Internal backplane for mounting system modules
4. Door tamper switch

5. Optional integral power supply with battery charging capability and Integral mounting brackets for housing backup batteries
6. UL listed
- B. Specifications:
 1. Dimensions: $\geq 14.5''w \times 18''h \times 4''d$
 2. Optional Power Supply:
 - a. Input: ≥ 0.5 Amp at 120 Volts AC
 - b. Output: ≥ 4 Amps at 12 Volts DC
- C. Basis of Design:
 1. Altronix Trove1 / Trove 2
- D. Acceptable Alternates:
 1. AMAG
 2. Andover
 3. Identiv Hirsch
 4. Lenel
 5. Open Options
 6. RS2
 7. TYCO Software House
- E. Provide complete with:
 1. Minimum 1"x1" slotted finger duct as required for internal routing of cabling from where it enters the panel enclosure to termination points on system components and modules.
 - a. Provide in larger dimensions as required to maintain maximum 40% fill.
 - 1) Fill calculation shall be based on anticipated amount of cable in a fully-populated panel enclosure.
 2. Minimum 3"x3" slotted finger duct around perimeter of each panel enclosure, with section of same duct product extended from perimeter of each panel enclosure to horizontal ladder rack above panel enclosure.
 - a. Provide in larger dimensions as required to maintain maximum 40% fill.
 - 1) Fill calculation shall be based on anticipated amount of cable associated with typical fully-populated panel enclosures.
- F. Where provided with integral power supply, provide complete with:
 1. Power supply sized to maintain $\leq 60\%$ average utilization of power supply output capacity.
 2. Quantity of 7 AH and/or 12 AH sealed lead acid or gel type batteries sufficient to provide a minimum of **[one (1) hour] [eight (8) hours] [twelve (12) hours]** twenty-four (24) hours of battery backup run time.

2.012 ELECTRIFIED DOOR LOCKING HARDWARE POWER SUPPLY

- A. Specified by Division 08.
 1. Refer to Division 08 for additional information and requirements.
- B. Furnished and installed by Division 08.
 1. Refer to Division 08 for additional information and requirements.
- C. Cabled, terminated, configured, programmed, tested, adjusted and made completely ready for use by This Contractor.
- D. Where not specified, furnished, and installed by Division 08:
 1. Features:
 - a. Wall mount
 - b. Steel enclosure with powder coat finish and lockable hinged door
 - c. Door tamper switch
 - d. Battery charging capability

- e. Integral mounting brackets for housing backup batteries
 - f. One common power input
 - g. Eight outputs
 - 1) 12 volt DC
 - 2) Filtered and electronically regulated
 - 3) PTC protected
 - 4) Independently controlled
 - a) Activated by dedicated open collector input or normally open dry contact input
 - 5) Fail safe or fail secure
 - h. Fire alarm disconnect input
 - 1) Normally open or normally closed
 - 2) Latching or non-latching
 - 3) Individually selectable for each output
 - i. LED indicators for AC input, DC output, individual output status, and fire alarm disconnect status
 - j. AC input fail supervision contact
 - k. Battery presence supervision contact
 - l. Low battery supervision contact
 - m. UL listed
2. Specifications:
- a. Dimensions: 14.5"w x 18"h x 4.62"d
 - b. Power Supply Input: 2.6 Amps at 120 Volts AC
 - c. Power Supply Output: 10 Amps at 12 Volts DC, total
 - d. Operating Temperature (Environmental): 32°F - 120°F
3. Basis of Design:
- a. Altronix AL1012ULACMCBJ
4. Acceptable Alternates:
- a. AMAG
 - b. Andover
 - c. Identiv Hirsch
 - d. Lenei
 - e. Mercury
 - f. Open Options
 - g. RS2
 - h. TYCO Software House
5. Provide complete with:
- a. Quantity of 7 AH and/or 12 AH sealed lead acid or gel type batteries sufficient to provide a minimum of **[one (1) hour] [eight (8) hours] [twelve (12) hours]** twenty-four (24) hours of battery backup run time.
 - b. \geq 3"x3" slotted finger duct around perimeter of each power supply enclosure, with section of same duct product extended from perimeter of each enclosure to horizontal ladder rack above enclosure.
 - 1) Provide in larger dimensions as required to maintain maximum 40% fill.
 - a) Fill calculation based on anticipated amount of cable associated with typical fully-populated panel enclosures.
6. Provide in quantity to maintain \leq 60% average utilization of power supply output capacity.

2.013 DIGITAL ALARM COMMUNICATION TRANSMITTER

- A. Features
 - 1. <FEATURES>
- B. Specifications
 - 1. <SPECIFICATIONS>
- C. Basis of Design:
 - 1. <BASIS OF DESIGN>
- D. Acceptable Alternates:
 - 1. <ACCEPTABLE ALTERNATE ONE>
 - 2. <ACCEPTABLE ALTERNATE TWO>

2.014 CREDENTIAL READERS

A. Mullion Mounted Short-Range Contactless Smart Credential Readers

- 1. Features:
 - a. IP-55 rated weather-resistant and vandal-resistant grey polycarbonate housing
 - b. Supports contactless smart credential technologies
 - c. Integral bi-color LED indicator
 - d. Integral sounder
 - e. Integral tamper switch
 - f. UL listed
- 2. Specifications:
 - a. Dimensions: 1.9"w x 4.1"h x 0.9" deep
 - b. Operating Frequency: 13.56 MHz
 - c. Read Range: 1.2 - 3.6", credential dependent
 - d. Output Communication Protocol: Wiegand, Clock-and-Data, Open Supervised Device Protocol via RS485
 - e. Input Voltage: 5-16 volts DC
 - f. Power Consumption, Average: 60 milliamps at 16 volts DC
 - g. Power Consumption, Peak: 200 milliamps at 16 volts DC
 - h. Connections: Terminal strip
 - i. Operating Temperature (Environmental): -31°F - 150°F
- 3. Basis of Design:
 - a. HID RP10
- 4. Acceptable Alternates:
 - a. None.

B. Wall Mounted Medium-Range Contactless Smart Credential Readers

- 1. Features:
 - a. IP-55 rated weather-resistant and vandal-resistant grey polycarbonate housing
 - b. Mounts to a standard single gang electrical opening
 - c. Supports contactless smart credential technologies
 - d. Integral bi-color LED indicator
 - e. Integral sounder
 - f. Integral tamper switch
 - g. UL listed
- 2. Specifications:
 - a. Dimensions: 3.3"w x 4.8"h x 1.1" deep
 - b. Operating Frequency: 13.56 MHz
 - c. Read Range: 2.0 - 5.2", credential dependent
 - d. Output Communication Protocol: Wiegand, Clock-and-Data, Open Supervised Device Protocol via RS485
 - e. Input Voltage: 5-16 volts DC

- f. Power Consumption, Average: 65 milliamps at 16 volts DC
- g. Power Consumption, Peak: 200 milliamps at 16 volts DC
- h. Connections: Terminal strip
- i. Operating Temperature (Environmental): -31°F - 150°F

3. Basis of Design:

- a. HID R40

4. Acceptable Alternates:

- a. None.

C. Wall Mounted Medium-Range Contactless Smart Keypad Credential Readers

1. Features:

- a. IP-55 rated weather-resistant and vandal-resistant grey polycarbonate housing
- b. Mounts to a standard single gang electrical opening
- c. Supports contactless smart credential technologies
- d. Integral keypad
- e. Integral bi-color LED indicator
- f. Integral sounder
- g. Integral tamper switch
- h. UL listed

2. Specifications:

- a. Dimensions: 3.3"w x 4.8"h x 1.1" deep
- b. Operating Frequency: 13.56 MHz
- c. Read Range: 2.0 - 5.5", credential dependent
- d. Output Communication Protocol: Wiegand, Clock-and-Data, Open Supervised Device Protocol via RS485
- e. Input Voltage: 5-16 volts DC
- f. Power Consumption, Average: 85 milliamps at 16 volts DC
- g. Power Consumption, Peak: 220 milliamps at 16 volts DC
- h. Connections: Terminal strip
- i. Operating Temperature (Environmental): -31°F - 150°F

3. Basis of Design:

- a. HID RK40

4. Acceptable Alternates:

- a. None.

D. Wall Mounted Long-Range Contactless Smart Credential Readers

1. Features:

- a. IP-65 rated weather-resistant and vandal-resistant grey polycarbonate housing
- b. Mounts to a standard single gang electrical opening
- c. Supports contactless smart credential technologies
- d. Integral bi-color LED indicator
- e. Integral sounder
- f. Integral tamper switch
- g. UL listed

2. Specifications:

- a. Dimensions: 13.1"w x 13.1"h x 1.55" deep
- b. Operating Frequency: 13.56 MHz
- c. Read Range: 3.1 - 14.2", credential dependent
- d. Output Communication Protocol: Wiegand, Clock-and-Data, Open Supervised Device Protocol via RS485
- e. Input Voltage: 12 or 24 volts DC
- f. Power Consumption, Average: 110 milliamps at 12 volts DC

- g. Power Consumption, Peak: 300 milliamps at 12 volts DC
 - h. Connections: Terminal strip
 - i. Operating Temperature (Environmental): -31°F - 150°F
3. Basis of Design:
- a. HID R90
4. Acceptable Alternates:
- a. None.
- E. Mullion Mounted Short-Range Multi-Technology Credential Readers
1. Features:
- a. IP-55 rated weather-resistant and vandal-resistant grey polycarbonate housing
 - b. Supports contactless smart and proximity credential technologies
 - c. Integral bi-color LED indicator
 - d. Integral sounder
 - e. Integral tamper switch
 - f. UL listed
2. Specifications:
- a. Dimensions: 1.9"w x 4.1"h x 0.9" deep
 - b. Operating Frequency: 13.56 MHz, 125 kHz
 - c. Read Range, Proximity: 0.8 - 4.3", credential dependent
 - d. Read Range, Contactless Smart: 0.8 - 3.1", credential dependent
 - e. Output Communication Protocol: Wiegand, Clock-and-Data, Open Supervised Device Protocol via RS485
 - f. Input Voltage: 5-16 volts DC
 - g. Power Consumption, Average: 75 milliamps at 12 volts DC
 - h. Power Consumption, Peak: 200 milliamps at 12 volts DC
 - i. Connections: Terminal strip
 - j. Operating Temperature (Environmental): -31°F - 150°F
3. Basis of Design:
- a. HID RP10
4. Acceptable Alternates:
- a. None.
- F. Wall Mounted Medium-Range Multi-Technology Credential Readers
1. Features:
- a. IP-55 rated weather-resistant and vandal-resistant grey polycarbonate housing
 - b. Mounts to a standard single gang electrical opening
 - c. Supports contactless smart and proximity credential technologies
 - d. Integral bi-color LED indicator
 - e. Integral sounder
 - f. Integral tamper switch
 - g. UL listed
2. Specifications:
- a. Dimensions: 3.3"w x 4.8"h x 1.0" deep
 - b. Operating Frequency: 13.56 MHz, 125 kHz
 - c. Read Range, Proximity: 1.2 - 4.3", credential dependent
 - d. Read Range, Contactless Smart: 1.2 - 4.7", credential dependent
 - e. Output Communication Protocol: Wiegand, Clock-and-Data, Open Supervised Device Protocol via RS485
 - f. Input Voltage: 5-16 volts DC
 - g. Power Consumption, Average: 85 milliamps at 12 volts DC
 - h. Power Consumption, Peak: 200 milliamps at 12 volts DC

- i. Connections: Terminal strip
- j. Operating Temperature (Environmental): -31°F - 150°F

3. Basis of Design:

- a. HID RP40

4. Acceptable Alternates:

- a. None.

G. Wall Mounted Medium-Range Multi-Technology Keypad Credential Readers

1. Features:

- a. IP-55 rated weather-resistant and vandal-resistant grey polycarbonate housing
- b. Mounts to a standard single gang electrical opening
- c. Supports contactless smart and proximity credential technologies
- d. Integral keypad
- e. Integral bi-color LED indicator
- f. Integral sounder
- g. Integral tamper switch
- h. UL listed

2. Specifications:

- a. Dimensions: 3.3"w x 4.8"h x 1.1" deep
- b. Operating Frequency: 13.56 MHz, 125 kHz
- c. Read Range, Proximity: 1.2 - 3.1", credential dependent
- d. Read Range, Contactless Smart: 0.8 - 4.7", credential dependent
- e. Output Communication Protocol: Wiegand, Clock-and-Data, Open Supervised Device Protocol via RS485
- f. Input Voltage: 5-16 volts DC
- g. Power Consumption, Average: 95 milliamps at 12 volts DC
- h. Power Consumption, Peak: 200 milliamps at 12 volts DC
- i. Connections: Terminal strip
- j. Operating Temperature (Environmental): -31°F - 150°F

3. Basis of Design:

- a. HID RPK40

4. Acceptable Alternates:

- a. None.

2.015 CREDENTIALS

A. Contactless Smart Cards

1. Features

- a. <FEATURES>

2. Specifications

- a. <SPECIFICATIONS>

3. Basis of Design:

- a. HID 3050

4. Acceptable Alternates:

- a. None.

B. Contactless Smart Fobs

1. Features

- a. <FEATURES>

2. Specifications

- a. <SPECIFICATIONS>

3. Basis of Design:

- a. HID 3250

4. Acceptable Alternates:
 - a. None.
- C. Proximity Cards
 1. Features
 - a. <FEATURES>
 2. Specifications
 - a. <SPECIFICATIONS>
 3. Basis of Design:
 - a. HID 1326
 4. Acceptable Alternates:
 - a. None.
- D. Proximity Fobs
 1. Features
 - a. <FEATURES>
 2. Specifications
 - a. <SPECIFICATIONS>
 3. Basis of Design:
 - a. HID 1346
 4. Acceptable Alternates:
 - a. None.

2.016 ELECTRIFIED DOOR LOCKING HARDWARE

- A. Provided Division 08. Refer to Division 08 for additional information and requirements.
- B. Cabled, terminated, configured, programmed, tested, adjusted and made completely ready for use by This Contractor.

2.017 LATCH BOLT MONITORS

- A. Provided Division 08. Refer to Division 08 for additional information and requirements.
- B. Cabled, terminated, configured, programmed, tested, adjusted and made completely ready for use by This Contractor.

2.018 DOOR POSITION MONITORS

- A. Provided Division 08. Refer to Division 08 for additional information and requirements.
- B. Cabled, terminated, configured, programmed, tested, adjusted and made completely ready for use by This Contractor.

2.019 REQUEST TO EXIT DEVICES

- A. Request to Exit Switch integral to Electrified Door Locking Hardware
 1. Provided Division 08. Refer to Division 08 for additional information and requirements.
 2. Cabled, terminated, configured, programmed, tested, adjusted and made completely ready for use by This Contractor.
- B. Motion-Sensing Request to Exit Devices
 1. Features:
 - a. Black ABS plastic housing
 - b. Wall or ceiling mountable
 - c. Adjustable pitch
 - d. Adjustable coverage pattern
 - e. Adjustable relay latch time
 - f. Integral activation LED
 - g. UL listed
 2. Specifications:
 - a. Alarm Output: Form C relay contacts rated at 1 amp at 30 volts DC

- b. Power Consumption, Average: 8 milliamps at 12 volts DC
- c. Power Consumption, Peak: 39 milliamps at 12 volts DC
- d. Operating Temperature (Environmental): -20°F - 120°F

3. Basis of Design:

- a. Bosch DS161

4. Acceptable Alternates:

- a. None.

5. Provide complete with same manufacturer's matching trim plate accessory for mounting over a single gang electrical opening.

C. Push-Button Request to Exit Devices with Pneumatic Timer

1. Features:

- a. Single gang stainless steel faceplate
- b. Wall mountable
- c. Red mushroom button
 - 1) Engraved with "PUSH TO EXIT" in white text
- d. Integral field-adjustable pneumatic time delay
- e. UL listed

2. Specifications:

- a. Alarm Output: Form C relay contacts rated ≥ 2 amps at 28 volts DC
- b. Time Delay Range: $\geq 2 - 45$ seconds

3. Basis of Design:

- a. Alarm Controls TS-60

4. Acceptable Alternates:

- a. Camden
- b. Rutherford

2.020 LOCAL ANNUNCIATOR

A. Sounder

1. Features:

- a. <FEATURES>

2. Specifications:

- a. <SPECIFICATIONS>

3. Basis of Design:

- a. <BOD>

4. Acceptable Alternates:

- a. None.

B. Strobe

1. Features:

- a. <FEATURES>

2. Specifications:

- a. <SPECIFICATIONS>

3. Basis of Design:

- a. <BOD>

4. Acceptable Alternates:

- a. None.

C. Sounder / Strobe

1. Features:

- a. <FEATURES>

2. Specifications:

- a. <SPECIFICATIONS>

3. Basis of Design:
 - a. <BOD>
4. Acceptable Alternates:
 - a. None.

2.021 TAMPER MONITOR

- A. Tamper Monitor Integral to Equipment or Device by Others
 1. Equipment or Device by Others includes:
 - a. Automated External Defibrillator
 - b. Knox Box
 2. Provided by Others. Refer to Providing Entity for additional information and requirements.
 3. Cabled, terminated, configured, programmed, tested, adjusted and made completely ready for use by This Contractor.
- B. Tamper Monitor
 1. Features:
 - a. <FEATURES>
 2. Specifications:
 - a. <SPECIFICATIONS>
 3. Basis of Design:
 - a. <BOD>
 4. Acceptable Alternates:
 - a. None.

2.022 DOOR RELEASE BUTTON

- A. Under-Counter Door Release Button
 1. Features:
 - a. Surface mount
 - b. Stainless steel housing
 - c. Momentary switch action
 - d. UL listed
 2. Specifications:
 - a. Contact Rating: 5 Amps at 30 Volts DC
 - b. Connections: Wire pigtails
 - c. Operating Temperature (Environmental): 14 - 140°F
 3. Basis of Design:
 - a. Schlage 660-PB
 4. Acceptable Alternates:
 - a. None.
- B. Wall Mount Door Release Button
 1. Features:
 - a. Wall mount
 - b. Stainless steel single gang faceplate
 - c. Momentary switch action
 - d. UL listed
 2. Specifications:
 - a. Contact Rating: 5 Amps at 30 Volts DC
 - b. Connections: Wire pigtails
 - c. Operating Temperature (Environmental): 14 - 140°F
 3. Basis of Design:
 - a. Schlage 660-PB

4. Acceptable Alternates:
 - a. None.

2.023 DURESS / PANIC BUTTON

- A. Under Desk Mount Duress / Panic Button
 1. Features:
 - a. ABS plastic housing
 - b. Silent operation
 - c. Latching switch action
 - d. UL listed
 2. Specifications:
 - a. Power Consumption: 8 milliamps at 12 volts DC
 - b. Contact Rating: 0.2 Amps at 30 Volts DC
 - c. Connections: Cable lead pigtail
 - d. Operating Temperature (Environmental): 0 - 110°F
 3. Basis of Design:
 - a. Interlogix 3050
 4. Acceptable Alternates:
 - a. Bosch
 - b. DSC
- B. Wall Mount Duress / Panic Button
 1. Features:
 - a. Single gang stainless steel faceplate
 - b. Mushroom-style push button
 - c. "EMERGENCY PUSH FOR HELP" markings
 - d. Latching switch action
 - e. UL listed
 2. Specifications:
 - a. Contact Rating: 1 amp at 30 Volts DC
 - b. Connections: Terminal Block
 - c. Operating Temperature (Environmental): -13 - 158°F
 3. Basis of Design:
 - a. Alarm Controls KR
 4. Acceptable Alternates:
 - a. Camden
 - b. SDC

2.024 ELECTRONIC ACCESS CONTROL CABLE

- A. General
 1. Refer to manufacturer's published product installation instructions for additional information and requirements. Wherever a discrepancy is identified between Project Documents and manufacturer's published product installation instructions, the more stringent requirement shall govern.
 2. Cable shall be plenum or riser rated as dictated by the environment in which the cable is installed. Refer to Mechanical drawings for additional information and requirements.
 3. Cable installed in wet or damp locations, including, but not limited to, in-slab and buried conduit, shall be rated for installation in wet locations.
- B. Ethernet Cable and Connectivity
 1. **[Fiber Optic Ethernet Cable and Connectivity]**
 - a. **Backbone Cables**
 - 1) **Refer to Section 27 1000 for information and requirements.**

- b. **Device Cables**
 - 1) **Refer to Section 27 1000 for information and requirements.**
- c. **Patch Cables**
 - 1) **Refer to Section 27 1600 for information and requirements]**
- 2. Twisted Pair Copper Ethernet Cable and Connectivity
 - a. Device Cables
 - 1) Refer to Section 27 1000 for information and requirements.
 - b. Patch Cables
 - 1) Refer to Section 27 1600 for information and requirements
- C. RS-485, RS-422 Cable
 - 1. 18/3 shielded
 - 2. Low-capacitance
 - 3. Basis of Design:
 - a. Plenum: Belden 88770
 - b. Nonplenum: Belden 8770
 - 4. Acceptable Alternates:
 - a. West Penn
- D. Credential Reader Cable
 - 1. 18/6 shielded
 - 2. Basis of Design:
 - a. Plenum: Belden 6304FE
 - b. Nonplenum: Belden 5304FE
 - 3. Acceptable Alternates:
 - a. West Penn
- E. Electrified Door Locking Hardware Cable
 - 1. Minimum 14/2 unshielded
 - a. Provide in gauge(s) as required to maintain no more than 10% voltage drop
 - 2. Basis of Design:
 - a. Plenum: Belden 6100UE
 - b. Nonplenum: Belden 5100UE
 - 3. Acceptable Alternates:
 - a. West Penn
- F. Latch Bolt Monitor Cable
 - 1. 18/2 unshielded
 - 2. Basis of Design:
 - a. Plenum: Belden 6300UE
 - b. Nonplenum: Belden 5300UE
 - 3. Acceptable Alternates:
 - a. West Penn
- G. Door Position Monitor Cable
 - 1. 18/2 unshielded
 - 2. Basis of Design:
 - a. Plenum: Belden 6300UE
 - b. Nonplenum: Belden 5300UE
 - 3. Acceptable Alternates:
 - a. West Penn
- H. Request to Exit Device Cable
 - 1. Request to Exit Switch integral to Electrified Door Locking Hardware
 - a. 18/2 unshielded

- b. Basis of Design:
 - 1) Plenum: Belden 6300UE
 - 2) Nonplenum: Belden 5300UE
- c. Acceptable Alternates:
 - 1) West Penn
- 2. Motion-Sensing Request to Exit Devices
 - a. 18/4 unshielded
 - b. Basis of Design:
 - 1) Plenum: Belden 6302UE
 - 2) Nonplenum: Belden 5302UE
 - c. Acceptable Alternates:
 - 1) West Penn
- I. Local Alarm Sounder Cable
 - 1. 18/2 unshielded
 - 2. Basis of Design:
 - a. Plenum: Belden 6300UE
 - b. Nonplenum: Belden 5300UE
 - 3. Acceptable Alternates:
 - a. West Penn
- J. Local Alarm Strobe Cable
 - 1. 18/2 unshielded
 - 2. Basis of Design:
 - a. Plenum: Belden 6300UE
 - b. Nonplenum: Belden 5300UE
 - 3. Acceptable Alternates:
 - a. West Penn
- K. Local Alarm Sounder/Strobe Cable
 - 1. 18/2 unshielded
 - 2. Basis of Design:
 - a. Plenum: Belden 6300UE
 - b. Nonplenum: Belden 5300UE
 - 3. Acceptable Alternates:
 - a. West Penn
- L. Automatic Door Operator Integration Cable
 - 1. 18/2 unshielded
 - 2. Basis of Design:
 - a. Plenum: Belden 6300UE
 - b. Nonplenum: Belden 5300UE
 - 3. Acceptable Alternates:
 - a. West Penn
- M. Automatic Door Operator Actuator Integration Cable
 - 1. Push Button Automatic Door Operator Actuator
 - a. 18/2 unshielded
 - b. Basis of Design:
 - 1) Plenum: Belden 6300UE
 - 2) Nonplenum: Belden 5300UE
 - c. Acceptable Alternates:
 - 1) West Penn
 - 2. Contactless "Hands-Free" Automatic Door Operator Actuator

- a. 18/4 unshielded
 - 1) Basis of Design
 - a) Plenum: Belden 6302UE
 - b) Nonplenum: Belden 5302UE
 - b. Acceptable Alternates:
 - 1) West Penn
- N. Duress/Panic Button Cable
 - 1. 18/2 unshielded
 - 2. Basis of Design:
 - a. Plenum: Belden 6300UE
 - b. Nonplenum: Belden 5300UE
 - 3. Acceptable Alternates:
 - a. West Penn
- O. System Equipment Panel Door Tamper Monitor Cable
 - 1. 18/2 unshielded
 - 2. Basis of Design:
 - a. Plenum: Belden 6300UE
 - b. Nonplenum: Belden 5300UE
 - 3. Acceptable Alternates:
 - a. West Penn
- P. Knox-Style Key Vault Door Tamper Monitor Cable
 - 1. 18/2 unshielded
 - 2. Basis of Design:
 - a. Plenum: Belden 6300UE
 - b. Nonplenum: Belden 5300UE
 - 3. Acceptable Alternates:
 - a. West Penn
- Q. Automated External Defibrillator (AED) Tamper Monitor Cable
 - 1. 18/2 unshielded
 - 2. Basis of Design:
 - a. Plenum: Belden 6300UE
 - b. Nonplenum: Belden 5300UE
 - 3. Acceptable Alternates:
 - a. West Penn

2.025 ELECTRONIC ACCESS CONTROL RACEWAYS AND BOXES

- A. Refer to Section 26 0533 for additional information and requirements.
- B. Device Back Boxes:
 - 1. Wall Mounted Devices:
 - a. Dimensions: Minimum 4" square, 2-1/8" deep
 - b. Plaster Ring: Single gang
 - 2. Door Frame Mounted Devices
 - a. Dimensions: Minimum 4" x 2", 1-1/4" deep
- C. Conduit:
 - 1. Wall Mounted Devices:
 - a. Minimum 3/4" trade size.
 - 2. Door Frame Mounted Devices:
 - a. Minimum 1/2" trade size.
 - 3. No flexible conduit of any type.
 - 4. No conduit bodies or conduit outlet bodies of any type.

2.026 ELECTRONIC ACCESS CONTROL SURFACE RACEWAYS

- A. Refer to 26 0533 for additional information and requirements.
- B. Size device back box per applicable code, in accordance with device manufacturer's recommendations, and to match form factor of device.
- C. Minimum raceway capacity equivalent to 3/4" trade size conduit.

PART 3 - EXECUTION

3.01 PRE-CONSTRUCTION COORDINATION MEETING

- A. Prior to preparing and submitting shop drawings, Contractor shall arrange and conduct pre-construction coordination meeting to review and coordinate Electronic Access Control installation requirements.
 - 1. Attendees shall include:
 - a. Owner's project manager, security representative, and facilities / buildings and grounds / maintenance door representative
 - b. Construction Manager / General Contractor project manager and site superintendent / field foreman
 - c. Division 08 subcontractor site superintendent / field foreman
 - d. Door frame, leaf, and hardware supplier representative(s)
 - e. Door hardware manufacturer's representative
 - f. Division 26 subcontractor site superintendent / field foreman
 - g. Division 28 project manager and site superintendent / field foreman
 - h. Electronic access control subcontractor/supplier representative
 - 2. At a minimum, meeting agenda topics shall include:
 - a. Review and coordination of division of work among trades.
 - b. Identification and review of each door to be equipped with electronic access control devices, to include:
 - 1) Location
 - 2) Intended functionality and operation
 - 3) Door hardware complement
 - 4) Electronic access control device complement
 - 5) Electronic access control device and cable rough-in requirements
 - c. Review of construction schedule and coordination of inter-trade installation schedule interdependencies
 - d. Coordination of door frame and door leaf mounted electronic access control device installation and wiring
 - e. Coordination of device configuration, testing, and adjustment
 - 3. Meeting shall be scheduled with a minimum of two weeks' notice.
 - a. Contractor shall publish a meeting agenda for the meeting and distribute to invited attendees a minimum of one week prior to the meeting.
 - 4. Contractor shall take detailed notes during the meeting and publish meeting minutes within one week after the meeting. Minutes shall be distributed to attendees, the Architect, and the Engineer.

3.02 CONFIGURATION AND PROGRAMMING COORDINATION MEETING

- A. After Section 28 1000 shop drawings have been approved, Contractor shall arrange and conduct a configuration and programming coordination meeting to review and coordinate aspects of Electronic Access Control device and equipment configuration and programming.
 - 1. At a minimum, attendees shall include:
 - a. Owner's project manager, security representative, and facilities / buildings and grounds / maintenance door representative
 - b. Division 28 project manager and site superintendent / field foreman

- c. Electronic access control subcontractor/supplier project manager and system programmer
2. At a minimum, meeting agenda topics shall include:
 - a. Identification and review of each door to be equipped with electronic access control devices, to include:
 - 1) Location
 - 2) Intended functionality and operation
 - 3) Door hardware complement
 - 4) Electronic access control device complement
 - 5) Configuration of and programming for each device
 - b. Identification and review of electronic access control devices not associated with a door, to include:
 - 1) Location
 - 2) Intended functionality and operation
 - 3) Configuration of and programming for each device
 - c. Review of a product-specific configuration and programming guide detailing configuration and programming options applicable to the system software, hardware, equipment, and devices being provided.
 - d. Configuration of credential holder database and programming of individual credential holders
 - e. Configuration and programming of system server(s) and workstations and of server/workstation graphical user interface screens
 - f. Review of installation, configuration, programming, and testing schedule, and of how those relate to the overall construction schedule.
3. Meeting shall be held a minimum of two weeks prior to the commencement of configuration and programming work, and shall be scheduled with a minimum of two weeks' notice.
 - a. Contractor shall publish a meeting agenda for the meeting and distribute the meeting agenda and configuration and programming guide to invited attendees a minimum of one week prior to the meeting.
4. Contractor shall take detailed notes during the meeting and publish meeting minutes within one week after the meeting. Minutes shall be distributed to attendees, the Architect, and the Engineer.

3.03 GENERAL

- A. Refer to Section 28 0000 for additional information and requirements.

3.04 [LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN]

- A. **[Refer to Section 28 0000 for additional information and requirements.]**

3.05 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 28 0000 for additional information and requirements.

3.06 LOCATIONS OF WORK

- A. Refer to Section 28 0000 for additional information and requirements.

3.07 FLOOR, WALL, CEILING, AND ROOF OPENINGS

- A. Refer to Section 28 0000 for additional information and requirements.

3.08 EQUIPMENT ACCESS

- A. Refer to Section 28 0000 for additional information and requirements.

3.09 EQUIPMENT SUPPORTS

- A. Refer to Section 28 0000 for additional information and requirements.

3.010 SUPPORT PROTECTION

- A. Refer to Section 28 0000 for additional information and requirements.

3.011 CABLE AND CONDUCTOR PROTECTION

- A. Refer to Section 28 0000 for additional information and requirements.

3.012 HOUSEKEEPING PADS

- A. Refer to Section 28 0000 for additional information and requirements.


3.013 LEAD SHIELDING

- A. Refer to Section 28 0000 for additional information and requirements.

3.014 INSTALLATION

- A. Refer to Section 28 0000 for additional information and requirements.
- B. General
 - 1. **[Integrate new work under this project in to Owner's existing system.]**
- C. System Servers and Application Software
 - 1. Coordinate exact location with Owner and work by other trades prior to installation.
 - 2. Coordinate schedule for activating power with on-site Division 26 Contractor prior to the commencement of work on site.
 - 3. Properly ground system servers with minimum 6 AWG bonding conductor terminated with two-hole compression lugs. Refer to Section 270526 for additional information and requirements.
 - 4. Provide surge protective device in-line just before connection to electrical receptacle.
 - 5. Provide surge protective device in-line just before connection to Ethernet jack.
 - 6. Coordinate configuration of server operating system software with Owner and with system application software manufacturer prior to installation and configuration.
 - 7. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
- D. System Workstations and Application Software
 - 1. Coordinate exact location with Owner and work by other trades prior to rough-in.
 - 2. Coordinate power requirements, connection locations, and schedule for activating power with on-site Division 26 Contractor prior to the commencement of work on site.
 - 3. Provide surge protective device in-line just before connection to electrical receptacle.
 - 4. Provide surge protective device in-line just before connection to Ethernet jack.
 - 5. Coordinate configuration of workstation operating system software with Owner and with system application software manufacturer prior to installation and configuration.
 - 6. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
- E. Intelligent System Controllers, Credential Reader Interface Modules, Input Control Modules, and Output Control Modules
 - 1. Install intelligent system controllers and input/output control modules centralized in manufacturer's matching wall-mounted control panel enclosures in the nearest Equipment Room. Coordinate exact location(s) with Owner and work by other trades prior to installation.
 - a. Electronic access control panel enclosure power supplies shall be fed via minimum 20-amp emergency power electrical circuit, dedicated to electronic access control system head end equipment.
 - 1) Provide machine-generated label on interior of the panel enclosure door indicating the name and number of the room where the electrical distribution panel the circuit originates in is located, the name/number of the distribution panel, and the number of the circuit.
 - 2) Provide hard-wired surge protective device in-line just before connection to the power supply.

- b. Coordinate power requirements, connection locations, and schedule for activating power with on-site Division 26 Contractor prior to the commencement of work on site.
 - c. Properly ground system control panel cabinets and system components with minimum 6 AWG bonding conductor terminated with two-hole compression lugs. Refer to Section 27 0526 for additional information and requirements.
 2. Cable shields and drain conductors of system communications cabling linking controllers in multiple locations shall be bonded to ground at primary system equipment location only.
 3. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
- F. Electronic Access Control Power Supplies
1. Install electronic access control power supplies wall-mounted immediately adjacent to associated electronic access control panel enclosures. Coordinate exact location(s) with Owner and work by other trades before installation.
 2. Electronic access control power supplies shall be fed via minimum 20-amp critical power electrical circuit, dedicated to electronic access control system head end equipment.
 - a. Provide machine-generated label on interior of the power supply enclosure door indicating the name and number of the room where the electrical distribution panel the circuit originates in is located, the name/number of the distribution panel, and the number of the circuit.
 - b. Provide hard-wired surge protective device in-line just before connection to the power supply.
 3. Coordinate power requirements, connection locations, and schedule for activating power with on-site Division 26 Contractor prior to the commencement of work on site.
 4. Properly ground electronic access control power supplies with minimum 6 AWG bonding conductor terminated with two-hole compression lugs. Refer to Section 270526 for additional information and requirements.
 5. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
- G. Credential Readers
1. Coordinate exact locations with Owner, Architectural elevations, and work by other trades prior to rough-in.
 2. Coordinate rough-in requirements with Division 26 Contractor prior to the commencement of work on site.
 3. Install in accordance with the Americans with Disabilities Act and the Americans with Disabilities Act Accessibility Guidelines.
 4. Where readers are specified to be installed on both sides of a wall, maintain sufficient physical separation between them to prevent cross-reading of credentials through the wall.
 5. Mount with security screw fasteners provided with the credential reader.
 6. Mount exterior credential readers with stainless steel fasteners.
 7. Provide surge suppression for exterior credential readers not mounted directly on the exterior wall of the building or directly on the exterior side of a door mullion.
 8. Cable shields and drain conductors of credential reader cabling shall be bonded to ground at credential reader interface module location only.
 9. Configure with tamper switch monitor alarm enabled.
 10. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
- H. Electrified Door Locking Hardware
1. Coordinate rough-in requirements with Division 08 Contractor and Division 26 Contractor prior to the commencement of work on site.

2. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
 3. Coordinate cabling, termination, testing, and adjustment with on-site Division 08 Contractor.
- I. Latch Bolt Monitors
1. Coordinate rough-in requirements with Division 08 Contractor and Division 26 Contractor prior to the commencement of work on site.
 2. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
 3. Coordinate cabling, termination, testing, and adjustment with on-site Division 08 Contractor.
- J. Door Position Monitors
1. Coordinate rough-in requirements with Division 08 Contractor and Division 26 Contractor prior to the commencement of work on site.
 2. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
 3. Coordinate cabling, termination, testing, and adjustment with on-site Division 08 Contractor.
- K. Request to Exit Devices
1. Request to Exit Switch integral to Electrified Door Locking Hardware
 - a. Coordinate rough-in requirements with Division 08 Contractor and Division 26 Contractor prior to the commencement of work on site.
 - b. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
 - c. Coordinate cabling, termination, testing, and adjustment with on-site Division 08 Contractor.
 2. Motion-Sensing Request to Exit Devices
 - a. Coordinate rough-in requirements with Division 26 Contractor prior to the commencement of work on site.
 - b. Coordinate exact locations with Owner, Architectural elevations, and work by other trades prior to rough-in.
 - c. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
 - d. Mask sensor lens, aim, tune, and adjust as necessary to minimize false activation from persons passing by but not exiting through the portal while still maintaining necessary REXing functionality.
- L. Local Alarm Sounders, Strobes, and Sounder/Strobes
1. Coordinate exact locations with Owner, Architectural elevations, and work by other trades prior to rough-in.
 2. Coordinate rough-in requirements with Division 26 Contractor prior to the commencement of work on site.
 3. Mount exterior local alarm sounders, strobes, and sounder/strobes with stainless steel fasteners.
 4. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
- M. System Equipment Panel Door Tamper Monitors
1. 
- N. Duress/Panic Button Control Panels
1. Install duress/panic button control panels centralized in the nearest Equipment Room. Coordinate exact location(s) with Owner and work by other trades before installation.
 - a. Duress/panic button control panels shall be fed via minimum 20-amp critical power electrical circuit, dedicated to electronic access control system head end equipment.

- 1) Provide machine-generated label on interior of the panel enclosure door indicating the name and number of the room where the electrical distribution panel the circuit originates in is located, the name/number of the distribution panel, and the number of the circuit.
- b. Coordinate power requirements, connection locations, and schedule for activating power with on-site Division 26 Contractor prior to the commencement of work on site.
- c. Properly ground system control panel cabinets and system components with minimum 6 AWG bonding conductor terminated with two-hole compression lugs. Refer to Section 27 0526 for additional information and requirements.
2. Coordinate provision of analog phone lines with Owner. Cross-connect Owner-provided analog phone lines to Duress/Panic Button Control Panel and configure dial-out functionality with Owner's remote monitoring service provider.
3. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
 - a. Integrate with Intelligent System Controllers and Input Control Modules to provide annunciation of duress/panic button activation through Electronic Access Control system software user interface.
- O. Duress/Panic Buttons
 1. Coordinate exact locations with Owner, Architectural elevations, and work by other trades prior to rough-in.
 2. Coordinate rough-in requirements with Division 26 Contractor prior to the commencement of work on site.
 3. Install in accordance with the Americans with Disabilities Act and the Americans with Disabilities Act Accessibility Guidelines.
 4. Coordinate installation and routing of device cable from 4" square x 2-1/8" deep back box at nearest wall to actual device location with Owner and casework or modular furniture prior to rough-in. Provide back box with single gang plaster ring, minimum 3/4" EMT conduit to cable tray above nearest accessible ceiling, and faceplate that supports method of routing cable from box to device.
 5. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
- P. Fire Alarm System Integration
 - 1.
- Q. Automatic Door Operator and Automatic Door Operator Actuator Integration
 - 1.
- R. Knox-Style Key Vault Door Tamper Monitor Integration
 - 1.
- S. Automated External Defibrillator (AED) Tamper Monitor Integration
 - 1.
- T. Electronic Access Control Cable
 1. Electronic Access Control System cabling shall be installed in conduit from device location to cable tray below nearest accessible floor or above nearest accessible ceiling.
 2. Install cabling in pathways provided, or as designated on floor plans, and support from building structure.
 - a. Where installed in free-air, support cables using J-hook type cable supports. Refer to Section 27 0528.29 - Hangers and Supports for Communications Systems for installation requirements.
 - 1) J-hook fill capacities shall be per manufacturer's recommendations and shall consider diameter of cable type(s) being installed.
 - 2) Route cable/hooks at right angles, parallel to construction.
 - b. Where installed in Cable Tray, lay cables neatly in tray.

- 1) [Do not tie.] [Secure cable bundles using hook and loop ties at [XXX]ft. intervals].
- 2) Provide sufficient slack in cables to allow for unequal expansion coefficients of cable tray and cables. This requirement is in addition to slack required at cable tray expansion joints.
3. Identification:
 - a. Label system device cabling with unique alphanumeric identifiers that include:
 - 1) Architectural door number
 - 2) Associated system device
 - 3) Unique alphanumeric identifier to distinguish between multiple instances of same device type at a door, where applicable
 - b. Refer to Section **27 0553** for additional information and requirements.
- U. Electronic Access Control Raceways and Boxes
 1. Refer to Section 280000 for additional information and requirements.
 2. Conduits:
 - a. **[At Contractor's option, Electronic Access Control conduit home runs from EAC-controlled doorways to Security Equipment Rooms may be consolidated in to larger conduits.**
 - 1) **Where conduit home runs are consolidated, size larger conduits to provide conduit capacity equal to or greater than cumulative capacity of the smaller conduits being combined.**
 - 2) **Prior to the commencement of work on site, prepare and submit for review shop drawings documenting proposed conduit consolidation, including proposed conduit sizing, junction boxes, and conduit routes coordinated with work by other trades.**
 - 3) **Prior to rough-in, field-coordinate final routing of larger conduits on site with work by other trades.]**
- V. Electronic Access Control Surface Raceways
 1. Refer to 280000 for additional information and requirements.
- W. Configuration and Programming
 1. Coordinate configuration and programming with Owner.
 2. Coordinate IP address requirements with Owner a minimum of six weeks prior to commencement of programming work.

3.015 INSPECTION AND TESTING

- A. Refer to Section 28 0000 for additional information and requirements.
- B. After successful completion of testing and prior to final acceptance, verify final operation of each controlled and/or monitored portal on site with Owner.
- C. Verification Follow-Up Visits
 1. Contractor shall include in their bid a minimum of two (2) unique visits to the site to review operation of each controlled and/or monitored portal and system device on site with Owner.
 2. Schedule of Visits:
 - a. The first of these visits will occur within six (6) months of substantial completion, or at Owner's request, whichever comes first.
 - b. The second of these visits will occur within twelve (12) months of substantial completion, or at Owner's request, whichever comes first.
 - c. Contractor shall tentatively coordinate scheduling for both visits upon substantial completion of work on site, but before final acceptance of the project.

3. At a minimum, Contractor shall provide for an average of fifteen (15) minutes per controlled and/or monitored portal or system device installed under this project or a total of eight (8) hours on site for each visit, whichever is longer.
4. After each visit, Contractor shall prepare a report detailing observation of operation at each controlled and/or monitored portal or system device, discussion about each controlled and/or monitored portal or system device with Owner, and adjustments made.
5. Contractor's bid shall include all labor costs associated with visits, to include:
 - a. Off-site pre-preparation time
 - b. On-site time
 - c. Travel time
 - d. Off-site report preparation time

3.016 START-UP

- A. Refer to Section 28 0000 for additional information and requirements.

3.017 DOCUMENTATION

- A. Refer to Section 28 0000 for additional information and requirements.

3.018 CLEANING

- A. Refer to Section 28 0000 for additional information and requirements.

3.019 [ATTIC STOCK]

- A. Refer to Section 280000 for additional information and requirements.
- B. Provide the following spare devices and equipment as Owner's attic stock:
 1. [Intelligent System Controllers: 5% of the quantity installed of each type provided, minimum one (1) of each type provided.]
 2. [Credential Reader Interface Modules: 5% of the quantity installed of each type provided, minimum one (1) of each type provided.]
 3. [Input Control Modules: 5% of the quantity installed of each type provided, minimum one (1) of each type provided.]
 4. [Output Control Modules: 5% of the quantity installed of each type provided, minimum one (1) of each type provided.]
 5. [Power Supplies: 5% of the quantity installed of each type provided, minimum one (1) of each type provided.]
 6. [Credential Readers: 10% of the quantity installed of each type provided, minimum one (1) of each type provided.]
 7. [Motion-Sensing Request to Exit Devices: 10% of the quantity installed of each type provided, minimum one (1) of each type provided.
 - a. Include same manufacturer's matching trim plate accessory for mounting over a single gang electrical opening]
 8. [Duress/Panic Buttons: 10% of the quantity installed of each type provided, minimum one (1) of each type provided.]
 9. [Surge Suppressors: 100% of the quantity installed of each type provided.]
 10. [Fuses: 20% of each type provided as part of system devices and equipment, minimum ten (10) of each type provided.]

3.020 TRAINING

- A. Refer to Section 28 0000 for additional information and requirements.
- B. Contractor shall provide to Owner's designated representative(s) a minimum of **[one (1)] [two (2)] [1-hour] [4-hour] [8-hour]** on-site training **session[s]** related to work under this section within fifteen (15) **[thirty (30)] [seven (7)]** days of substantial completion.

END OF SECTION

**SECTION 28 2300
VIDEO SURVEILLANCE**

PART 1 - GENERAL

1.01 SCOPE

- A. This section includes product and execution requirements for Video Surveillance. Unless noted otherwise, work under this section is subject to requirements of Section 28 0000.

1.02 DESCRIPTION

- A. Refer to Section 28 0000 for additional information and requirements.
- B. Complete, turnkey Video Surveillance system compliant with applicable codes and standards referenced herein and as indicated on drawings.
- C. The Video Surveillance system shall include the following major components:
1. [Video Surveillance System Application Software]
 2. [Video Surveillance System Server(s)]
 3. [Video Surveillance System Networked Video Storage]
 4. [Video Surveillance System Workstation(s)]
 5. [Ethernet Networking Electronics]
 6. [Video Surveillance Cameras]
 7. [Media Converters]
 8. [Video Surveillance Cable]
 9. [Video Surveillance Raceways and Boxes]
 10. [Video Surveillance Surface Raceways]
- D. [Video Surveillance shall be provided by Owner's incumbent vendor, [NAME OF OWNER'S INCUMBENT VENDOR], under subcontract to Contractor.
1. [NAME OF OWNER'S INCUMBENT VENDOR]
 - a. Contact: [OWNER'S INCUMBENT VENDOR'S CONTACT'S FIRST AND LAST NAME]
 - b. Street Address: [OWNER'S INCUMBENT VENDOR'S ADDRESS]
 - c. Telephone: [OWNER'S INCUMBENT VENDOR'S CONTACT'S PHONE NUMBER, WITH AREA CODE]
 - d. Email: [OWNER'S INCUMBENT VENDOR'S CONTACT'S EMAIL ADDRESS]

1.03 RELATED WORK

- A. Refer to Section 28 0000 for additional information and requirements.

1.1 REQUIREMENTS OF REGULATORY AGENCIES

- A. Refer to Section 28 0000 for additional information and requirements.

1.2 REFERENCES AND STANDARDS

- A. Refer to Section 28 0000 for additional information and requirements.

1.04 DEFINITIONS

- A. Refer to Section 28 0000 for additional information and requirements.

1.05 ABBREVIATIONS AND ACRONYMS

- A. Refer to Section 28 0000 for additional information and requirements.

1.06 LISTING

- A. Refer to Section 28 0000 for additional information and requirements.

1.07 SUBMITTALS

- A. Shop Drawings:
1. Refer to Section 28 0000 for additional information and requirements.
 2. Submit a Video Surveillance Camera Schedule that includes for each camera all information in Video Surveillance Camera Schedule on the drawings, plus the following:

- a. Camera IP address
 - b. Camera subnet mask
 - c. Required PoE power, in watts
- B. Certificates and Inspections
1. Refer to Section 28 0000 for additional information and requirements.
- C. Operation and Maintenance Manuals
1. Refer to Section 28 0000 for additional information and requirements.
 2. Provide a still image from each installed video surveillance camera:
 - a. Obtained at full resolution at the time of final acceptance
 - b. Scaled to and printed on a standard 8-1/2" x 11" sheet, one image per sheet
 - c. Marked with text indicating camera's unique alphanumeric identifier and network address
- D. Record Documents
1. Refer to Section 28 0000 for additional information and requirements.
 2. For each video surveillance camera, indicate the following:
 - a. Installed location of camera
 - b. Direction camera is aimed
 - c. Camera's field of view
 - 1) Indicated by an isosceles triangle with it's apex at the camera and it's base at the vertical plane the camera is focused to.
 - a) Length of base of triangle shall match the horizontal width of the field of view the camera is focused to.

1.08 JOB CONDITIONS

- A. Refer to Section 28 0000 for additional information and requirements.

1.09 WORK BY OWNER

- A. Refer to Section 28 0000 for additional information.
- B. Owner will provide:
 1. [[Existing] Video Surveillance system Server(s) [and Application Software]]
 2. [[Existing] Video Surveillance system Networked Video Storage]
 3. [[Existing] Video Surveillance system Workstation(s) [and Application Software]]
 4. [[Existing] Ethernet Networking Electronics]

1.010 QUALITY ASSURANCE

- A. Refer to Section 28 0000 for additional information and requirements.

1.011 GUARANTEE

- A. Refer to Section 28 0000 for additional information and requirements.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Refer to Section 28 0000 for additional information and requirements.
- B. Unless noted otherwise, the following equipment and devices shall be the products of a single manufacturer and designed, manufactured, marketed, sold, and supported as an integrated system:
 1. [Video Surveillance System Application Software]
 2. [Video Surveillance System Server(s)]
 3. [Video Surveillance System Networked Video Storage]
 4. [Video Surveillance System Workstation(s)]
 5. [Video Surveillance Cameras]

2.02 VIDEO SURVEILLANCE SYSTEM APPLICATION SOFTWARE

- A. **[Existing to remain.]**
 - 1. **[LIST MANUFACTURER, TRADE NAME, AND VERSION OF EXISTING SOFTWARE]**
- B. Features
 - 1. <FEATURES>
- C. Specifications
 - 1. <SPECIFICATIONS>
- D. Basis of Design:
 - 1. TYCO exacq exacqVision
- E. Acceptable Alternates:
 - 1. AMAG Symmetry CompleteView
 - 2. Genetec Omnicast
 - 3. Identiv 3VR VisionPoint
 - 4. Milestone XProtect
 - 5. OnSSI Ocularis
 - 6. Salient CompleteView 20/20
 - 7. TYCO American Dynamics Victor
- F. Provide licenses required for new work specified in Contract Documents and to provide functionality specified in Contract Documents.

2.03 VIDEO SURVEILLANCE SYSTEM SERVER HARDWARE

- A. Features
 - 1. <FEATURES>
- B. Specifications
 - 1. <SPECIFICATIONS>
- C. Basis of Design:
 - 1. Lenovo
- D. Acceptable Alternates:
 - 1. Dell
 - 2. Hewlett-Packard
- E. Provide licenses required for new work specified in Contract Documents and to provide functionality specified in Contract Documents.

2.04 VIDEO SURVEILLANCE SYSTEM NETWORKED VIDEO STORAGE APPLIANCE(S)

- A. Features
 - 1. <FEATURES>
- B. Specifications
 - 1. <SPECIFICATIONS>
- C. Basis of Design:
 - 1. Dell
- D. Acceptable Alternates:
 - 1. Hewlett-Packard
 - 2. Pure Storage
- E. Provide licenses required for new work specified in Contract Documents and to provide functionality specified in Contract Documents.

2.05 VIDEO SURVEILLANCE SYSTEM WORKSTATION HARDWARE

- A. Features
 - 1. <FEATURES>
- B. Specifications
 - 1. <SPECIFICATIONS>
- C. Basis of Design:

1. Lenovo
- D. Acceptable Alternates:
 1. Dell
 2. Hewlett-Packard
- E. Provide licenses required for new work specified in Contract Documents and to provide functionality specified in Contract Documents.

2.06 ETHERNET SWITCHES

- A. Features
 1. <FEATURES>
- B. Specifications
 1. <SPECIFICATIONS>
- C. Basis of Design:
 1. Cisco
- D. Acceptable Alternates:
 1. Juniper
 2. Hewlett-Packard
- E. Provide licenses required for new work specified in Contract Documents and to provide functionality specified in Contract Documents.

2.07 VIDEO SURVEILLANCE CAMERAS

- A. Type 1 - Flush Indoor Ceiling Mounted Fixed Dome Camera, 2 MP
 1. Features:
 - a. IK10-rated tamper resistant housing
 - b. Transparent dome
 - c. PoE powered
 - d. Wide dynamic range
 - e. Day/Night
 - f. Remote zoom and focus
 - g. Digital PTZ
 - h. Multi-view streaming
 - i. Built-in microphone
 - j. Supports two-way audio
 - k. Supports SD/SDHC/SDXC cards
 2. Specifications:
 - a. Image Sensor: 1/2.8" RGB CMOS
 - b. Focal Length: 3 - 9mm, F1.3
 - c. Minimum Illumination, Color: 0.2 lux, F1.3
 - d. Minimum Illumination, B/W: 0.04 lux, F1.3
 - e. Shutter Time: 1/33500 - 2s
 - f. Camera Angle Adjustment, Pan: 360°
 - g. Camera Angle Adjustment, Tilt: 160°
 - h. Camera Angle Adjustment, Rotation: 340°
 - i. Video Compression: H.264
 - j. Resolution: 1920x1080 (2 MP)
 - k. Frame Rate: 30fps @ 60 Hz
 - l. Power Consumption: 4.2 watts
 - m. Operating Temperature (Environmental): 32 - 122°F
 - n. Network Connection: RJ-45, 10BASE-T/100BASE-T PoE
 - o. Audio Input Connection: 1/8", mic/line level
 - p. Audio Output Connection: 1/8", line level

- q. Alarm Input Connection: Terminal Block
- r. Alarm Output Connection: Terminal Block
- 3. Basis of Design:
 - a. Axis P3365-V
- 4. Acceptable Alternates:
 - a. None.
- B. Type 2 - Flush Indoor/Outdoor Ceiling Mounted Fixed Dome Camera, 5 MP
 - 1. Features:
 - a. IP66-rated weather proof and IK-10-rated tamper resistant housing
 - b. Transparent dome
 - c. PoE powered
 - d. Wide dynamic range
 - e. Day/Night
 - f. Remote zoom and focus
 - g. Digital PTZ
 - h. Multi-view streaming
 - i. Supports two-way audio
 - j. Supports SD/SDHC/SDXC cards
 - 2. Specifications:
 - a. Image Sensor: 1/3.2" RGB CMOS
 - b. Focal Length: 3 - 9mm, F1.2
 - c. Minimum Illumination, Color: 0.2 lux, F1.2
 - d. Minimum Illumination, B/W: 0.04 lux, F1.2
 - e. Shutter Time: 1/28 0000 - 2s
 - f. Camera Angle Adjustment, Pan: 360°
 - g. Camera Angle Adjustment, Tilt: 160°
 - h. Camera Angle Adjustment, Rotation: 340°
 - i. Video Compression: H.264
 - j. Resolution: 2592x1944 (5 MP)
 - k. Frame Rate: 12fps @ 60 Hz (5 MP), 20fps @ 60 Hz (3 MP), 30fps @ 60 Hz (2 MP)
 - l. Power Consumption: 12.1 watts
 - m. Operating Temperature (Environmental): -40 - 131°F
 - n. Network Connection: RJ-45, 10BASE-T/100BASE-T PoE
 - o. Audio Input Connection: 1/8", mic/line level
 - p. Audio Output Connection: 1/8", line level
 - q. Alarm Input Connection: Terminal Block
 - r. Alarm Output Connection: Terminal Block
 - 3. Basis of Design:
 - a. Axis P3367-VE
 - 4. Acceptable Alternates:
 - a. None.
- C. Type 3 - Flush Indoor/Outdoor Ceiling Mounted IR Dome Camera, 2 MP
 - 1. Features:
 - a. IP66-rated weather proof and IK-8-rated tamper resistant housing
 - b. Transparent dome
 - c. PoE powered
 - d. Wide dynamic range
 - e. Day/Night
 - f. Built-in microphone
 - g. Supports two-way audio

- h. Supports SD/SDHC/SDXC cards
- 2. Specifications:
 - a. Image Sensor: 1/3" CMOS
 - b. Focal Length: 2.8mm, fixed
 - c. Minimum Illumination, Color: 0.1 lux, F1.2
 - d. Minimum Illumination, IR: 0.0 lux, F1.2
 - e. Shutter Time: 1/10,000 - 1/3s
 - f. IR Range: 30 ft
 - g. Video Compression: H.264
 - h. Resolution: 1920x1080 (2 MP)
 - i. Frame Rate: 30fps @ 60 Hz
 - j. Power Consumption: 5 watts
 - k. Operating Temperature (Environmental): -22 - 140°F
 - l. Network Connection: RJ-45, 10BASE-T/100BASE-T PoE
 - m. Audio Input Connection: 1/8", mic/line level
 - n. Audio Output Connection: 1/8", line level
 - o. Alarm Input Connection: Terminal Block
 - p. Alarm Output Connection: Terminal Block
- 3. Basis of Design:
 - a. Interlogix TVW-5302
- 4. Acceptable Alternates:
 - a. None.
- D. Type 4 - Flush Indoor/Outdoor Ceiling Mounted IR Dome Camera, 4 MP
 - 1. Features:
 - a. IP66-rated weather proof and IK-8-rated tamper resistant housing
 - b. Transparent dome
 - c. PoE powered
 - d. Wide dynamic range
 - e. Day/Night
 - f. Built-in microphone
 - g. Supports two-way audio
 - h. Supports SD/SDHC/SDXC cards
 - 2. Specifications:
 - a. Image Sensor: 1/3" CMOS
 - b. Focal Length: 2.8mm, fixed
 - c. Minimum Illumination, Color: 0.1 lux, F1.2
 - d. Minimum Illumination, IR: 0.0 lux, F1.2
 - e. Shutter Time: 1/10,000 - 1/3s
 - f. IR Range: 30 ft
 - g. Video Compression: H.264
 - h. Resolution: 2688x1520 (4 MP)
 - i. Frame Rate: 30fps @ 60 Hz
 - j. Power Consumption: 5 watts
 - k. Operating Temperature (Environmental): -22 - 140°F
 - l. Network Connection: RJ-45, 10BASE-T/100BASE-T PoE
 - m. Audio Input Connection: 1/8", mic/line level
 - n. Audio Output Connection: 1/8", line level
 - o. Alarm Input Connection: Terminal Block
 - p. Alarm Output Connection: Terminal Block
 - 3. Basis of Design:

- a. Interlogix TVW-5305
- 4. Acceptable Alternates:
 - a. None.

2.08 MEDIA CONVERTERS

- A. Features:
 - 1. One channel of full duplex electrical to optical Ethernet conversion
 - 2. 1000 Mbps fiber transmission via OS 2 single mode fiber optic SFP module
 - 3. 10/100/1000 Mbps copper transmission via integral RJ-45 connector
 - 4. IEEE802.3at PoE+ output
- B. Specifications:
 - 1. Power Connection: Terminal Block
 - 2. Optical Connection: SFP Slot
 - 3. Copper Connection: RJ-45
 - 4. Power Consumption: 35 watts at 48-57 volts DC
 - 5. Operating Temperature (Environmental): -40 - 167°F
- C. Basis of Design:
 - 1. ComNet CNMCSFPPOE/M
- D. Acceptable Alternates:
 - 1. None
- E. Provide complete with manufacturer's matching SFP module, power supply, and minimum of 24 hours of battery backup capacity.

2.09 VIDEO SURVEILLANCE CABLE

- A. General
 - 1. Refer to manufacturer's published product installation instructions for additional information and requirements. Wherever a discrepancy is identified between Project Documents and manufacturer's published product installation instructions, the more stringent requirement shall govern.
 - 2. Cable shall be plenum or riser rated as dictated by the environment in which the cable is installed.
 - a. Refer to Mechanical drawings for additional information and requirements.
 - 3. Cable installed in wet or damp locations, including, but not limited to, in-slab and buried conduit, shall be rated for installation in wet locations.
- B. Ethernet Cable and Connectivity
 - 1. **[Fiber Optic Ethernet Cable and Connectivity]**
 - a. **Backbone Cables**
 - 1) **Refer to Section 27 1000 for information and requirements.**
 - b. **Device Cables**
 - 1) **Refer to Section 27 1000 for information and requirements.**
 - c. **Patch Cables**
 - 1) **Refer to Section 27 1600 for information and requirements]**
 - 2. Twisted Pair Copper Ethernet Cable and Connectivity
 - a. Device Cables
 - 1) Refer to Section 27 1000 for information and requirements.
 - b. Patch Cables
 - 1) Refer to Section 27 1600 for information and requirements
- C. Low-Voltage Power Cable
 - 1. Minimum 18/2 unshielded
 - a. Provide in gauge(s) as required to maintain no more than 10% voltage drop
 - 2. Basis of Design:

- a. Belden
- 3. Acceptable Alternates:
 - a. West Penn
- D. Microphone and Line-Level Audio Cable
 - 1. 18/2 shielded
 - 2. Low-capacitance
 - 3. Basis of Design:
 - a. Plenum: Belden 88770
 - b. Nonplenum: Belden 8770
 - 4. Acceptable Alternates:
 - a. West Penn

2.010 VIDEO SURVEILLANCE RACEWAYS AND BOXES

- A. Refer to Section 26 0533 for additional information and requirements.
- B. Device Back Boxes:
 - 1. Dimensions: Minimum 4" square, 2-1/8" deep
- C. Conduit:
 - 1. Minimum 3/4" trade size.
 - 2. No flexible conduit of any type.
 - 3. No conduit bodies or conduit outlet bodies of any type.

2.011 VIDEO SURVEILLANCE SURFACE RACEWAYS

- A. Refer to 26 0533 for additional information and requirements.
- B. Size device back box per applicable code, in accordance with device manufacturer's recommendations, and to match form factor of device.
- C. Minimum raceway capacity equivalent to 3/4" trade size conduit.

PART 3 - EXECUTION

3.01 CONFIGURATION AND PROGRAMMING COORDINATION MEETING

- A. After Section 28 2300 shop drawings have been approved, Contractor shall arrange and conduct a configuration and programming coordination meeting to review and coordinate all aspects of Video Surveillance device and equipment configuration and programming.
 - 1. At a minimum, attendees shall include:
 - a. Owner's project manager and security representative
 - b. Division 28 project manager and site superintendent / field foreman
 - c. Video Surveillance subcontractor/supplier project manager and system programmer
 - 2. At a minimum, meeting agenda topics shall include:
 - a. Identification and review of each video surveillance camera, to include:
 - 1) Intended field of view
 - 2) Intended use for video
 - 3) Mounting location
 - 4) Camera type and mount type/configuration
 - 5) General configuration and programming
 - 6) Network address
 - 7) Configuration of recorded video (resolution, frame rate, etc.)
 - b. Review of a product-specific configuration and programming guide detailing all configuration and programming options applicable to the system software, hardware, equipment, and devices being provided.
 - c. Configuration and programming of system server(s) and workstations and of server/workstation graphical user interface screens

- d. Review of installation, configuration, programming, and testing schedule, and of how those relate to the overall construction schedule.
3. Meeting shall be held a minimum of two weeks prior to the commencement of work on site, and shall be scheduled with a minimum of two weeks' notice.
 - a. Contractor shall publish a meeting agenda for the meeting and distribute the meeting agenda and configuration and programming guide to all invited attendees a minimum of one week prior to the meeting.
4. Contractor shall take detailed notes during the meeting and publish meeting minutes within one week after the meeting. Minutes shall be distributed to attendees, the Architect, and the Engineer.

3.02 GENERAL

- A. Refer to Section 28 0000 for additional information and requirements.

3.03 [LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN]

- A. [Refer to Section 28 0000 for additional information and requirements.]

3.04 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 28 0000 for additional information and requirements.

3.05 LOCATIONS OF WORK

- A. Refer to Section 28 0000 for additional information and requirements.

3.06 FLOOR, WALL, CEILING, AND ROOF OPENINGS

- A. Refer to Section 28 0000 for additional information and requirements.

3.07 EQUIPMENT ACCESS

- A. Refer to Section 28 0000 for additional information and requirements.

3.08 EQUIPMENT SUPPORTS

- A. Refer to Section 28 0000 for additional information and requirements.

3.09 SUPPORT PROTECTION

- A. Refer to Section 28 0000 for additional information and requirements.

3.010 CABLE AND CONDUCTOR PROTECTION

- A. Refer to Section 28 0000 for additional information and requirements.

3.011 HOUSEKEEPING PADS

- A. Refer to Section 28 0000 for additional information and requirements.

3.012 LEAD SHIELDING

- A. Refer to Section 28 0000 for additional information and requirements.

3.013 INSTALLATION

- A. Refer to Section 28 0000 for additional information and requirements.
- B. General
 1. Integrate all new work under this project in to Owner's existing system.
- C. Video Surveillance Cameras
 1. Coordinate rough-in requirements with Division 26 Contractor prior to the commencement of work on site.
 2. Coordinate all locations with Owner and Division 26 Contractor prior to the commencement of work on site.
 3. Camera Mounting:
 - a. Cameras and mounting accessories shall be rigidly attached to back boxes rigidly attached to structural members.
 - b. Cameras installed in accessible ceiling tiles:
 - 1) Shall be supported by a tile bridge or other approved means

- 2) Shall not be supported by the ceiling tile
 - 3) Shall be equipped with a safety cable secured to camera housing and structural member above
 - c. Mount exterior cameras with stainless steel fasteners.
 4. Provide surge suppression for all exterior cameras, including exterior cameras connected via media converters.
 5. Provide media conversion for all cameras whose cabling exceeds maximum allowable length per applicable standards.
 6. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
 7. Field-coordinate field of view, aim, and focus with Owner prior to commencement of final testing.
 - a. Prior to final testing, Contractor shall, at no cost to Owner, make minor adjustments to camera locations and placement to address unanticipated obstructions to the field of view and/or unanticipated spatial interference.
 - 1) For the purposes of these adjustments, "minor" is defined as adjustments requiring relocation of up to six (6) feet from the location coordinated with the Owner during the Configuration and Programming Coordination Meeting.
- D. Media Converters
 1. Properly ground all media converter components and power supplies. Refer to Section 27 0526 for additional information and requirements.
- E. Cable
 1. All Video Surveillance System cabling shall be installed in conduit from device location to cable tray above nearest accessible ceiling.
 2. Install cabling in pathways provided, or as designated on floor plans, and support from building structure.
 - a. Where installed in free-air, support cables using J-hook type cable supports. Refer to Section 27 0528.29 - Hangers and Supports for Communications Systems for installation requirements.
 - 1) J-hook fill capacities shall be per manufacturer's recommendations and shall consider diameter of cable type(s) being installed.
 - 2) Route cable/hooks at right angles, parallel to construction.
 - b. Where installed in Cable Tray, lay cables neatly in tray.
 - 1) [Do not tie.] [Secure cable bundles using hook and loop ties at [XXX] m(ft.) intervals].
 - 2) Provide sufficient slack in cables to allow for unequal expansion coefficients of cable tray and cables. This requirement is in addition to slack required at cable tray expansion joints.
 3. Where work under this Section is installed in a pole, bollard, etc. on site shared by work under Division 26, all work under Division 26 in the shared pole, bollard, etc. shall be installed in metallic raceway and boxes from end to end.
 4. Systems Identification:
 - a. Label all system device cabling with unique alphanumeric identifiers that include:
 - 1) Video surveillance camera location:
 - a) Exterior cameras - General location on site, based on direction ("North", "Northeast", "East", "Southeast", etc.).
 - b) Interior cameras - Architectural room number
 - 2) Unique alphanumeric identifier
 - b. Refer to Section 27 0553 for additional information and requirements.
- F. Configuration and Programming
 1. Coordinate all configuration and programming with Owner.

2. Coordinate all IP address requirements with Owner a minimum of six weeks prior to commencement of programming work.
3. Integration with other systems
 - a.

3.014 INSPECTION AND TESTING

- A. Refer to Section 28 0000 for additional information and requirements.
- B. After successful completion of testing and prior to final acceptance, visually verify final field of view, aim, and focus of each video surveillance camera on site with Owner.
- C. Verification Follow-Up Visits
 1. Contractor shall include in their bid a minimum of two (2) unique visits to the site to review field of view, aim, and focus of each video surveillance camera with Owner.
 2. Schedule of Visits:
 - a. The first of these visits will occur within six (6) months of substantial completion, or at Owner's request, whichever comes first.
 - b. The second of these visits will occur within twelve (12) months of substantial completion, or at Owner's request, whichever comes first.
 - c. Contractor shall tentatively coordinate scheduling for both visits upon substantial completion of work on site, but before final acceptance of the project.
 3. At a minimum, Contractor shall provide for an average of fifteen (15) minutes per video surveillance camera installed under this project or a total of eight (8) hours on site for each visit, whichever is longer.
 4. After each visit, Contractor shall prepare a report detailing observation of each camera's operation, discussion about each camera with Owner, and adjustments made.
 5. Contractor's bid shall include all labor costs associated with visits, to include:
 - a. Off-site pre-preparation time
 - b. On-site time
 - c. Travel time
 - d. Off-site report preparation time

3.015 START-UP

- A. Refer to Section 28 0000 for additional information and requirements.

3.016 DOCUMENTATION

- A. Refer to Section 28 0000 for additional information and requirements.

3.017 CLEANING

- A. Refer to Section 28 0000 for additional information and requirements.

3.018 [ATTIC STOCK]

- A. **Refer to Section 28 0000 for additional information and requirements.**
- B. **Provide the following spare devices and equipment as Owner's attic stock:**
 1. **Video Surveillance Cameras: 10% of the quantity installed of each type provided, minimum one (1) of each type provided.**
 2. **Video Surveillance Camera Mounts: 10% of the quantity installed of each type provided, minimum one (1) of each type provided.**
 3. **Media Converters: 10% of the quantity installed of each type provided, minimum one (1) of each type provided.**
 4. **Media Converter Power Supplies: 10% of the quantity installed of each type provided, minimum one (1) of each type provided.**

3.019 TRAINING

- A. Refer to Section 28 0000 for additional information and requirements.

- B. Contractor shall provide to Owner's designated representative(s) a minimum of **[one (1)] [two (2)] [1-hour] [4-hour] [8-hour]** on-site training **session[s]** related to work under this section within fifteen (15) **[thirty (30)] [seven (7)]** days of substantial completion.

END OF SECTION

SECTION 28 3116
MULTIPLEXED FIRE DETECTION AND ALARM SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 14 2400 - Hydraulic Elevators
- B. Section 21 1314 - Automatic Fire Sprinkler System
- C. Section 26 0000 - General Electrical Requirements
- D. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables
- E. Section 26 0526 - Grounding and Bonding for Electrical Systems
- F. Section 26 0533 - Raceway and Boxes for Electrical Systems
- G. Section 26 0553 - Electrical Systems Identification

1.02 DESCRIPTION

- A. In general, work consists of:
 - 1. Furnish and install complete Multiplexed Fire Alarm System as shown on plans.
 - 2. System shall:
 - a. Be an intelligent analog system
 - b. Allow for loading and editing special instructions and operating sequences as required
 - c. Be capable of on-site programming to accommodate system expansion and facilitate changes in operation
 - d. Be wired, connected, and left in operating condition
 - 3. System includes:
 - a. Control Panel(s)
 - b. Annunciator Panel(s)
 - c. Manual Stations
 - d. Heat Detectors
 - e. Smoke Detectors
 - f. Alarm Indicating Devices
 - g. Terminations
 - h. Other necessary material for complete operating systems
 - 4. Software operations shall be stored in non-volatile programmable memory within fire alarm control panel. Loss of primary and secondary power shall not erase instructions stored in memory.

1.03 REFERENCE STANDARDS

- A. FBC - 2020 - Florida Building Code
- B. FFPC - 2020 - Florida Fire Prevention Code
- C. NECA 305 - Standard for Fire Alarm System Job Practices
- D. NFPA 72 - National Fire Alarm and Signaling Code
- E. NFPA 101 - Life Safety Code
- F. UL 268 - Smoke Detectors for Fire Protective Signaling Systems
- G. UL 497B - Protectors for Communications and Fire Alarm Circuits
- H. UL 521 - Heat Detectors for Fire Protective Signaling Systems
- I. UL 864 - Control Units for Fire Protective Signaling Systems
- J. UL 1480 - Speakers for Fire Protective Signaling Systems
- K. UL 1481 - Power Supplies for Fire Protective Signaling Systems
- L. UL 1711 - Amplifiers for Fire Protective Signaling Systems

1.04 QUALIFICATIONS

- A. Equipment shall be supplied by company specializing in fire alarm and smoke detection systems with 5 yrs documented experience

- B. Work shall be performed by licensed contractor, regularly engaged in installation and servicing of fire alarm systems.
- C. Furnish proof of 5 yrs documented experience and factory authorization to furnish and install equipment proposed.
- D. Contractor shall be located within 100 miles of Project site.

1.05 SUBMITTALS

- A. Submit bill of materials listing part number and quantity of components and devices.
- B. Submit general catalog cutsheets of all devices that are to be provided as part of system. Mark cutsheets with items specific to the project when multiple items are identified.
- C. Submit block diagrams showing layout and operation of entire system.
- D. Submit schematic diagrams, of circuits from field devices to terminal strip(s) associated with control panel.
 - 1. Diagrams shall show schematic wiring of equipment; and connections to be made to devices.
 - 2. Terminal connections in equipment shall be numbered to correspond to diagrams.
 - 3. Wiring diagrams shall be coordinated so that terminal numbering, circuit designation and equipment or device designations are same on drawings.
- E. Submit standby battery power calculations.
- F. Submit sound amplifier and strobe power supply calculations showing current draws for every device and module during standby, alarm and trouble conditions.
- G. Submit voltage drop calculations for both initiating and alarming circuits.
- H. Submit list of device addresses with location labeling as they will appear in 2 line, 40 character display of fire alarm panel and remote annunciator.
- I. Submit to Authority Having Jurisdiction (AHJ):
 - 1. Copy of shop drawings as required to show component locations.
 - 2. Upon receipt of comments from AHJ, make resubmissions if required to make clarifications or revisions to obtain approval.
 - 3. All fees associated with this shall be included in the bid.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Johnson Controls Inc (JCI)/Simplex
- B. Edwards Systems Technologies
- C. Honeywell
- D. Siemens Cerberus
- E. Equivalent that meets performance specifications

2.02 SYSTEM OPERATIONS

- A. Alarm Initiation
 - 1. System alarm operation after activation of any manual station, automatic detection device, or sprinkler flow switch shall be:
 - a. Appropriate initiating device circuit red LED shall flash on Control Panel and remote annunciator until the alarm has been acknowledged at Control Panel or remote annunciator.
 - b. Once acknowledged, this same LED shall latch on.
 - c. Subsequent alarm received after acknowledging shall flash subsequent zone alarm LED on Control Panel and remote annunciator.
 - d. Acknowledgment of alarm shall not reset activated device.
 - e. Pulsing alarm tone shall occur within Control Panel and remote annunciator until event has been acknowledged.

- f. Alarm audible-indicating devices shall sound in three pulse temporal pattern until silenced by alarm silence switch at Control Panel or remote annunciator.
 - g. Visual alarm indicating devices shall operate in continuous flashing pattern until system is reset.
 - h. Signal to notify the local fire department shall be activated.
 - i. Doors held open by door control devices shall close.
 2. System shall have single key to allow operator to display alarms, troubles, and supervisory service conditions, including time and date of each occurrence.
 3. Alarm shall be displayed on an 80-character LCD display as follows:
 - a. 40 characters for:
 - 1) Point address and loop number
 - 2) Type of device
 - 3) Point status
 - b. 40 characters for:
 - 1) Custom location label
- B. Silencing
 1. Alarm audible indicating devices shall be silenced by operating alarm silence switch or by use of key operated switch at remote annunciator.
 2. Strobes shall remain active until system is reset.
 3. Subsequent zone alarm shall reactivate alarm signals.
- C. Reset
 1. SYSTEM RESET button shall return system to its normal state after an alarm condition has been remedied.
- D. Supervision
 1. System shall independently supervise:
 - a. Initiating device circuits
 - b. Sprinkler flow and tamper switches
 - c. Independently fused indicating appliance circuits for alarm horn/strobe units
 - d. Auxiliary manual controls. "Off normal" position of any switch shall cause an "off normal" system trouble
 - e. Auxiliary circuits for addressable relays. Blown fuse or open in circuit shall be visibly and audibly annunciated.
 - f. Remote annunciator panel. Any ground, short, or open in the wiring to fire alarm Control Panel, as well as malfunction of the annunciator panel, shall be annunciated at control panel.
 - g. Incoming power. Power failure shall be audibly and visually indicated at Control Panel and remote annunciator. Green "power on" LED shall be displayed continuously while incoming power is present.
 - h. System Modules for module placement. Should modules become disconnected, system trouble indicator shall illuminate and audible trouble signal shall sound.
 - i. System batteries. Low battery condition or disconnection of battery shall be audibly and visually indicated at Control Panel and remote annunciator.
 2. Device activation shall be annunciated at Control Panel and remote annunciator.
 3. Independently supervised circuits shall include visible amber "Trouble" LED to indicate disarrangement conditions per circuit.
 4. Disarrangement conditions of any circuit shall not affect operation of other circuits.
 5. Alarm activation of any initiation circuit shall not prevent subsequent alarm operation of any other initiation circuit.
 6. System shall have provisions for disabling and enabling circuits individually for maintenance or testing purposes.

E. Power Requirements

1. Provide 120 VAC power via dedicated branch circuit in emergency panel.
2. Branch circuit shall have "breaker lock" to prevent accidentally de-energizing of power to fire alarm panel.
3. Circuit breaker shall be painted red and labeled "FIRE ALARM."
4. Provide disconnect switch for AC power near panel or within Fire Alarm Control Panel itself. Switch shall be labeled "Fire Alarm Power Disconnect."
5. Where new Control Panel is to remain at same location as existing panel, contractor may use existing branch circuit, if it meets requirements stated above.
6. Provide power surge and transient protection.
7. Provide back-up battery capacity to operate entire system in normal supervisory mode for period of 24 h with 10 minutes of alarm operation at end of period.
8. System shall automatically transfer to standby batteries upon power failure.
 - a. Battery charging and recharging operations shall be automatic.
9. Provide power limited, filtered and regulated battery charger.
 - a. Charger shall:
 - 1) Be combination high rate/float maintenance type
 - 2) Charge fully discharged battery to 70% in 12 h
 - 3) Monitor for AC fail/disconnect, low/no battery, and high battery level
 - 4) Include switches and associated LEDs for high rate and AC disconnect
 - 5) Provide 5 amps of regulated 24 VDC for peripheral devices requiring $\pm 5\%$ regulation and 8 amps at 24 VDC for standard peripheral devices.
 - 6) Be compatible with lead acid batteries
10. External circuits requiring system operating power shall be 24 VDC and shall be individually supervised and fused at Control Panel.

F. Smoke Detection Operation

1. Smoke detector alarms shall be processed and reported immediately.
2. Upon building completion, alarm verification shall be added to detector(s) as directed by project engineer.
3. Control Panel shall:
 - a. Be capable of displaying number of times (tally) detector has gone into verification mode from the system history
 - b. Download alarm set point to detector
 - c. Determine condition of each detector by comparing detector's value to stored values.
 - d. Maintain moving average of detectors' smoke chamber value to automatically compensate for dust and dirty conditions
 - e. Continuously perform an automatic self-test routine on each detector
 - f. Have capability of being programmed for pre-alarm or two-stage function
 - g. Clear "detector dirty" trouble after detector has been removed from its base cleaned and replaced
4. System shall maintain constant smoke obscuration sensitivity for each detector by compensating for environmental factors.
5. Photoelectric detector's smoke obscuration sensitivity shall be adjustable to within 0.3% of either limit of UL window (0.5% to 4.0%) to compensate for any environment.
6. System shall indicate when individual detector needs cleaning. When detector's average value reaches predetermined level, trouble MESSAGE shall be audible and visibly indicated at Control Panel. LED on detector base shall glow steady giving visible indication.
7. For scheduling of maintenance, Control Panel shall generate MESSAGE indication for any detector approaching trouble condition due to dirt or contamination.

8. Operator shall have capability to manually access the following information for each detector:
 - a. Primary status
 - b. Device type
 - c. Present average value
 - d. Present sensitivity value selected
 - e. Detector range (normal, dirty, etc.)
 9. Values at Control Panel shall be in "percent of smoke obscuration" format, so that no interpretation is required by operator.
 10. Operator shall be able to manually control following for each detector:
 - a. Enable or disable detector
 - b. Establish alarm sensitivity
 - c. Control detector's relay driver output
 11. It shall be possible to program Control Panel to automatically change sensitivity settings of each detector based on time-of-day and day-of-week. There shall be 3 sensitivity settings available for each detector.
- G. Elevator Recall Operation
1. When an elevator lobby or machine room smoke detector alarm is activated it shall cause Phase I Emergency Recall Operation according to following sequence:
 - a. If alarmed detector is on any floor other than main level of egress, elevator car(s) shall be recalled to main level of egress.
 - b. If alarmed detector is on main level of egress, elevator car(s) shall be recalled to predetermined alternate recall level as determined by Owner.
 2. Elevator lobby smoke detector shall annunciate on separate zone from other devices.
 3. Zoning shall be done by floor.
 4. Upon reset of Fire Alarm Control Panel, elevators shall automatically resume normal operations.
- H. Elevator Shunt Trip
1. After elevator machine room or elevator shaft heat detector is activated, elevator control panel shall deactivate shunt trip breaker supplying power to elevator.
 2. Specific elevator shaft zone shall be put into alarm and sound general fire alarm.
- I. System Response
1. Maximum elapsed time from sensing fire at non-smoke detector initiating device or second smoke detector until it is recorded at Control Panel and remote annunciator shall not exceed 5 seconds, and not exceed 15 seconds for remote station reporting.
- J. Air Handling Unit System Operation/Interface
1. Control Panel shall provide alarm interface to air handling/energy management system controllers, which shall perform automatic functions as specified in Division 23.
 2. Fire Alarm Control Panel shall provide manual control mode to override fire alarm panel's signal so that air handling units can be restarted.
- K. Sprinkler System Operation/Interface
1. Activation of any standpipe or sprinkler system tamper or water flow switch shall activate system supervisory service audible signal and illuminate LED at Control Panel and remote annunciator.
 2. Control Panel shall provide differentiation between switch operation and opens and/or grounds on initiation circuit wiring.
 3. Pressing acknowledge key will silence audible signal while maintaining supervisory service LED "on" indicating off-normal condition.
 4. Restoring valve to normal position shall cause supervisory service audible signal to pulse indicating restoration to normal position.

5. Acknowledge key shall silence audible signal.
- L. Manual Evacuation (Drill) Operation
 1. Manual evacuation (drill) switch shall be provided to operate alarm indicating appliances without causing other control circuits to be activated.
 2. Should true alarm occur, alarm functions would occur.
- M. LED and LCD Test Operation
 1. Activation of Lamp Test switch shall turn on all LED indicators, LCD display, and the local sounder and then return to previous condition.
- N. System Diagnosis
 1. System shall include special software to detect, diagnose and report failures and isolate such failures to printed circuit board level.
- O. Watch-Dog Timers
 1. System shall include independent "Watch-Dog" timers to detect and report failure of any microprocessor circuit, memory, or software.
- P. Walk Test Operation
 1. Actuation of "Walk Test" switch/program at Control Panel shall activate "Walk Test" mode of system, which shall cause following to occur:
 - a. Fire department circuit connection shall be bypassed.
 - b. Control relay functions shall be bypassed, such as elevator capture, fan shut down, etc.
 - c. Audio and visual circuits shall be bypassed.
 - d. Control Panel shall show trouble condition.
 - e. Alarm activation of initiation device shall cause audible signals to sound for 2 seconds.
 - f. Control Panel shall automatically reset itself after signaling is complete.
 - g. Momentary opening of initiating or indicating appliance circuit wiring shall cause audible signals to sound for 2 seconds indicating trouble condition.
 - h. If system becomes inactive for period of longer than 30 minutes, Control Panel shall default to normal fire alarm functions.
 - i. Activation of any initiation device shall be silently logged as an alarm condition in historical data file.
 2. Panel shall have capability of dividing system into distinctive walk test groups.
- Q. One-Way Voice Communications
 1. Automatic voice evacuation sequence shall be as follows:
 - a. Audio alarm signal shall consist of alarm tone for maximum of 2 seconds followed by temporal code-three. Temporal code-three shall sound until alarm silence switch at Fire Alarm Control Panel or the remote annunciator has been operated.
 - b. Audio alarm operations of speaker circuit selection and alarm tone timing variations shall be activated by system software so that required future changes to evacuation sequence or re-arrangements of audio circuits can be facilitated by authorized personnel without additional components or rewiring.
 2. All Call:
 - a. Upon activation of "All Call" switch, 2 seconds of tone shall sound over all speakers in system. At end of this tone, the operator shall be able to make announcements via push-to-talk paging microphone over all system speakers.
 - b. Strobes shall flash in all areas or floors.
 - c. System shall default to normal operations if the microphone becomes inactive for more than 1 minute.

2.03 ENCLOSURE

- A. Provide cabinets of sufficient size to accommodate equipment.

- B. Cabinet shall be equipped with door, with lock and transparent door panel, providing tamper proof enclosure and allowing full view of various lights and controls.

2.04 CONTROL PANEL

- A. Control Panel shall be modular, expandable with solid state, microprocessor based electronics.
- B. Control Panel shall provide the following features:
 - 1. Support intelligent (analog) detection devices.
 - 2. Number of initiating device loops required for specified quantity of initiating devices. Each active loop shall include 5% spare capacity.
 - 3. Number of indicating device (horn/speaker) circuits required for quantity of horns/speakers alarm. Each active circuit shall include 25% spare capacity.
 - 4. Number of indicating device (strobe) circuits required for specified quantity of strobes plus one (1) spare circuit for each **[10] [XXX]** active circuits. Each active circuit shall include 25% spare capacity.
 - 5. 80-character liquid crystal display
 - 6. Printer interface
 - 7. History log file with minimum of 600 events
 - 8. Field programmable
 - 9. Drift compensation
 - 10. Sensitivity display in %
 - 11. Sensitivity adjustment
 - 12. Day/night sensitivity adjustment
 - 13. Auto detector test
 - 14. Silent walk test
 - 15. Maintenance alerts
- C. System shall provide ability to recall alarms and trouble conditions in chronological order.
- D. Under normal condition viewing window shall display "System is Normal" message and current time and date.
- E. When an abnormal condition occurs appropriate LED (Alarm, Supervisory or Trouble) shall flash.
- F. Audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.
- G. Panel shall display the following information relative to abnormal condition of a point in system prior to acknowledgement:
 - 1. 40 characters for:
 - a. Point address and loop number
 - b. Type of device (i.e. smoke, pull station, water-flow)
 - c. Point status (i.e. alarm, trouble)
 - 2. 40 characters for:
 - a. Custom location label (i.e. 2nd Floor - Room 202)
- H. Keyboards or keypads shall not be required to operate the system during fire alarm conditions.
- I. Following software functions shall be provided:
 - 1. Setting of time and date
 - 2. LED testing
 - 3. Alarm, trouble, and abnormal condition listing
 - 4. Enabling and disabling of each monitor point separately
 - 5. Activation and deactivation of each control point separately
 - 6. Changing operator access levels
 - 7. Walk Test enable
 - 8. Running diagnostic functions
 - 9. Displaying historical logs

10. Point listing
- J. Following hardware functions shall be provided:
 1. Acknowledge alarm or trouble
 2. Silence alarm or trouble
 3. Reset system after alarm
 4. Connect/disconnect fire department tie
 5. Provide manual evacuation (drill)
 6. Bypass elevator recall and shunt trip operation
 7. Bypass door holders
 8. Allow computer interface

2.05 STATUS INDICATORS AND DISPLAYS

- A. Audible device shall sound during Alarm, Trouble or Supervisory conditions.
- B. Audible device shall sound during each key-press.
- C. Visual display shall distinguish between alarm, trouble and supervisory conditions.
- D. Indicators and displays to be visible:
 1. One red system alarm LED
 2. One yellow supervisory service LED
 3. One yellow trouble LED
 4. Green "power on" LED
 5. Eighty-character LCD
- E. 2-line by 40-character LCD shall be backlit.
- F. Cursor shall be visible on LCD when entering information.
- G. Scrolling through menu options shall be in self-directing manner in which prompting messages shall direct user.
- H. Controls shall be located behind an access door.
- I. Status data to be available on display:
 1. Initiating device circuits
 2. Indicating device circuits
 3. Auxiliary relays
 4. Primary State of point
 5. Zone information
 6. Class "A" Status
 7. Current priority of outputs
 8. Disable/Enable status
 9. Automatic/Manual Control Status of output points
 10. Acknowledge status

2.06 CONTROLS

- A. Controls (one switch per function per system) visible through front viewing window:
 1. Alarm Acknowledge key
 2. Trouble Acknowledge key
 3. Alarm Silence key
 4. System Reset key
- B. Controls accessible with front door open:
 1. Fire department disconnect/switch
 2. Manual evacuation (drill)
 3. Elevator bypass
 4. Fan shut down override/bypass switches
 5. Key pad for data input and microprocessor control

2.07 LED SUPERVISION

- A. Slave module LEDs shall be supervised. When problem occurs, LCD shall display module and LED location.

2.08 ACKNOWLEDGMENT

- A. Two methods of acknowledgment for each abnormal condition shall be provided:
 - 1. Acknowledge one event at a time from an unacknowledged list of events.
 - 2. Pressing acknowledge button shall display first unacknowledged condition in list (either alarm, supervisory or trouble), and require another acknowledge button. Press to acknowledge only displayed point.
- B. After all points have been acknowledged, LEDs shall glow steadily and alarm will be silenced. Total number of alarms, supervisory and trouble conditions shall be displayed.
- C. Pressing appropriate acknowledge button shall acknowledge all points
- D. Acknowledge functions shall be behind locked door or pass-code protected.

2.09 SILENCING

- A. If an alarm condition exists and "Alarm Silence" button is pressed, all alarm signals shall cease operation. Strobes shall remain active until system is reset.
- B. If trouble conditions exist in system and "Trouble Silence" button has been pressed, audible trouble signal shall cease, but shall resound at timed intervals to act as reminder that fire alarm system is not in normal operating mode.

2.010 RESET

- A. SYSTEM RESET button shall be used to return system to normal state after alarm condition has been remedied.
- B. Should an alarm condition continue to exist, system shall provide indications that resetting can not be completed and shall remain in an abnormal state.
- C. Sonalert and Alarm LED shall remain activated.
- D. Display shall indicate total number of alarms and troubles present in system along with prompt to use ACK keys to review points.
- E. Points shall not require acknowledgment if they were previously acknowledged.
- F. Should Alarm Silence Inhibit function be active, system shall ignore all key presses. An indication of enabling and disabling inhibit state shall be provided as feedback to operator.

2.011 ACCESS LEVELS

- A. Provide 4 access levels with level 4 being highest level. Level 1 actions shall not require pass-code.
- B. Pass-codes shall consist of up to 5 digits.
- C. Pass-code digits entered shall be displayed as an X to indicate that digit has been accepted.
- D. Key presses shall be acknowledged by local audible sound.
- E. When correct pass-code is entered, system shall indicate to operator "*Access Granted.*"
- F. Access level shall be in effect until operator manually logs out or keypad has been inactive for 5 minutes.
- G. Operator entering invalid code shall be notified with message "*Incorrect Pass- Code*" and shall be allowed three chances to enter valid code. After three unsuccessful tries, the message "*Access Denied*" shall be displayed.
- H. Following keys/switches shall have associated access levels:
 - 1. Alarm Silence
 - 2. System Reset
 - 3. Set Time/Date
 - 4. Manual Control
 - 5. On/Off/Auto Control
 - 6. Disable/Enable
 - 7. Programming functions

8. Clear Historical Alarm Log
9. Clear Historical Trouble Log
10. Walk Test

11. [Change Alarm Verification]

- I. Acknowledge keys shall require pass code access to acknowledge points. If operator presses an (ACK) key with insufficient access, an error message shall be displayed.

2.012 POINT LISTING

- A. Point list menu includes:
 1. All points list by address
 2. Monitor point list
 3. Signal/speaker list
 4. Auxiliary control list
 5. Feedback point list

2.013 HISTORY LOGGING

- A. System shall be capable of logging and storing the last 400 events (alarm and trouble) in history log. These events shall be stored in battery protected random access memory.
- B. Following historical alarm log events shall be stored:
 1. Alarms
 2. Alarm Acknowledgment
 3. Alarm Silence
 4. System Reset
 5. Alarm Historical log cleared
- C. Following historical trouble log events shall be stored:
 1. Trouble conditions
 2. Supervisory alarms
 3. Trouble acknowledgment
 4. Supervisory acknowledgment
 5. Walk Test results
 6. Trouble Historical log cleared

2.014 COMPUTER INTERFACE

- A. Control Panel shall operate as proprietary local system with capability of sending status data to and receiving control data from Central Processing Unit (CPU).
- B. CPU shall monitor all alarms and troubles and control selected functions of Control Panel.
- C. CPU shall supervise all data communication wiring between CPU and Control Panel for opens, shorts and grounds.

2.015 FIELD PROGRAMMING

- A. System shall be fully programmable, configurable, and expandable in field and shall not require replacement of memory IC's.
- B. Programming may be accomplished through Control Panel keyboard or use of PC.
- C. Programs shall be stored in non-volatile memory.
- D. Programming or reprogramming shall be done by supplier at no charge until system is accepted by Owner.

2.016 TERMINAL/PRINTER INTERFACE

- A. Control Panel shall be capable of operating remote monitors and/or printers.
- B. Output shall be ASCII from RS-232-C connection with an adjustable baud rate.
- C. Each RS-232-C port shall be capable of supporting and supervising up to 4 remote CRTs and Printers.
- D. Data amplifiers shall be used to increase CRT or printer line distance.

2.017 INTELLIGENT NETWORK

- A. System shall provide communications with intelligent initiating and control devices individually.
- B. Devices shall be individually annunciated at control panel.
- C. Annunciation shall include the following conditions for each point:
 - 1. Alarm
 - 2. Trouble
 - 3. Open
 - 4. Short
 - 5. Device missing/failed
- D. Devices shall have capability of being disabled or enabled individually.
- E. There shall be no limit to number of detectors, stations, or addressable modules, which may be activated or "in alarm" simultaneously.
- F. Multiple intelligent devices shall be connected to a single pair of wires.
- G. Communication format must be completely digital poll/response protocol to allow t-tapping of circuit wiring.

2.018 ONE-WAY VOICE COMMUNICATION SYSTEM

- A. Provide central audio control module for:
 - 1. Alarm message/tone generation
 - 2. Main and remote microphone connections
 - 3. Mixer/pre-amplifier circuits
 - 4. Continuous supervision shall be provided for all circuits, amplifiers and modules.
- B. Hand-held, push-to-talk microphone:
 - 1. Recessed in panel-mounted enclosure
 - 2. Dynamic communication type with frequency range of 200 Hz to 4000 Hz
 - 3. Equipped with self-winding 5' coiled cable
 - 4. LED indicator shall be provided to indicate microphone push-to-talk button has been pressed and speaker circuits are ready for transmission.
 - 5. Supervised for disconnection
- C. Audio control switch module:
 - 1. Provide manual access to audio operations personnel.
 - 2. Include "All circuits" switch, "Aux Tone" switch and tone generator stop switch
 - 3. Switches and LED indicators shall be supervised for disarrangement on failure.
- D. Automatic message player:
 - 1. Provide a pre-recorded digitized voice message to building occupants during alarm conditions
 - 2. Not rely on tape or other mechanical means of transmitting evacuation message
 - 3. Be capable of transmitting a custom message of up to 3 minutes long
- E. Self-contained speaker and switching arrangement shall provide testing of message(s) without disturbing occupants of the facility.
- F. Provide standard message, approved by Authority Having Jurisdiction.
- G. Audio power amplifiers:
 - 1. Be furnished with self-contained filtered 24 VDC power supply, transformer and amplifier monitoring circuits
 - 2. Provide 25 or 75 VRMS output with frequency response of 100 Hz to 7000 Hz
 - 3. Be constantly monitored
 - 4. Be current limited or disconnected from circuit should a short develop on speaker circuit
 - 5. Individual speaker circuits shall not be loaded more than 70% of rated amplifier power output.
- H. Provide amplifiers to operate system speakers at 1-watt tap simultaneously plus 50% reserve capacity.

- I. Provide at least one back-up amplifier capable of automatically replacing any failed amplifier. Stand-by amplifier shall be rated at same output capacity as the largest amplifier in evacuation system.
- J. Speaker and strobe circuits shall be zoned by floor or as noted on plans, with isolating module on each circuit.
- K. Audio Evacuation Supervision:
 - 1. Each speaker zone, amplifier, preamplifier, and power supply shall be supervised for component or circuit failure.
 - 2. Detection of amplifier failure shall automatically cause substitution of stand-by amplifier and shall activate trouble light and audible signal at console and initiate trouble alarm on fire alarm system.
 - 3. Provide minimum of one circuit for each zone or area of distinct communication.
- L. Manual Voice Paging Sequence
 - 1. System shall allow selective voice paging.
 - 2. An "All Call" switch shall be provided to allow for activation of all speakers.
 - 3. Control Panel shall provide a method for remote fire fighters telephone patch-in to one-way voice communication speakers.
 - 4. Manual operation shall be controlled at Fire Alarm Control Panel, or remote microphone; if provided.
- M. Tones
 - 1. Main evacuating tone shall be temporal code-three.
 - 2. Optional tones shall include:
 - a. Hi/Lo
 - 1) Free running tone with high frequency of 544 Hz and low frequency of 440 Hz
 - 2) "On time" (Hi) shall be 100 milliseconds while the "off time" (Lo) is 400 milliseconds.
 - b. Slow whoop
 - 1) Slowly ascending tone from 200 to 830 Hz in 2.5 seconds
 - 3. One primary and one secondary tone generator shall be furnished.
 - a. Automatic transfer to secondary unit should primary unit fail
 - b. Trouble signals shall indicate a failure of either primary or secondary unit.

2.019 REMOTE ANNUNCIATOR PANEL

- A. Provide 80-character LCD remote annunciator panel.
 - 1. LED annunciators will not be accepted.
- B. Annunciator shall provide:
 - 1. Control push-button switches for; alarm silence, trouble silence, system reset and LED and LCD test.
 - 2. Tone Alert - Duplicates Control Panel tone alert during alarm and trouble conditions
 - 3. System trouble LED
 - 4. System alarm LED
 - 5. Power on LED
- C. Annunciator shall communicate to Control Panel over one shielded twisted pair cable.
- D. Operating power shall be 24 VDC and be fused at control panel.
- E. Annunciator shall have black finish.
- F. Wiring between annunciator panel and Control Panel shall be supervised for opens, grounds and shorts.
- G. Under normal operating conditions, LCD shall indicate time, date and "SYSTEM IS NORMAL" label.
- H. During abnormal conditions, LCD shall indicate type and number of abnormal conditions, such as alarms, troubles, and supervisory services.

2.020 MULTIPLEXED PERIPHERAL DEVICES

- A. Devices shall be supervised for trouble conditions.
- B. Failure of device shall not hinder operation of other system devices.
- C. Device Identification
 - 1. Each intelligent device shall be identified by an address code.
 - 2. Location of end-of-line device shall be indicated on device that containing same.
 - 3. System must verify that proper type device is in place and matches software configuration.
- D. Intelligent Detector Bases
 - 1. Either base or head shall contain electronic circuits that communicate detector's status (normal, alarm, sensitivity status, trouble) to Control Panel over two wires. Same two wires shall also provide power to base and detector.
 - 2. Contacts between base and head shall be of bifurcated type using spring-type, self-wiping contacts.
 - 3. Base shall have locking capability. Locking feature must be field removable when not required.
 - 4. Upon removal of detector's head, trouble signal shall be transmitted to Control Panel.
 - 5. **[Detector base shall be sealed against rear airflow entry.]**
 - 6. Detector base or head shall contain LED(s) that flash when detector is being scanned by Control Panel.
 - 7. LED(s) shall turn on steady when detector is in alarm condition.
- E. Intelligent Detector Heads - General
 - 1. Intelligent detector heads shall be low-profile type.
 - 2. Heads shall be plug-in units, which mount to common base.
 - 3. Heads shall be 24 VDC type.
 - 4. Heads may be reset by actuating Control Panel reset switch.
 - 5. To minimize false alarms, voltage and RF transient suppression techniques shall be employed.
 - 6. Smoke detectors:
 - a. Listed for sensitivity testing from Control Panel.
 - b. Include an insect screen.
 - c. Communicate actual smoke chamber values to Control Panel.
 - d. Covered with plastic bags after installation to maintain cleanliness. Bags shall be red for quick visual identification for removal at time of occupancy.
 - 7. **[Install smoke detectors on circuits with alarm verification modules.]**
- F. Intelligent Photoelectric Smoke Detectors
 - 1. Detectors:
 - a. Contain no radioactive material
 - b. Be of solid state photoelectric type and shall operate on light scattering photodiode principle using pulsed infrared LED light.
- G. Intelligent Heat Detectors
 - 1. Detectors:
 - a. Be a combination rate-of-rise and fixed temperature (135°F unless noted).
 - b. Sense within temperature range of 32° to 158°F. The control panel shall be capable of sensing either a set point of 135°F, or a rate-of-rise of [15°F] [20°F] per minute for fire sensing.
- H. Intelligent Duct Smoke Detectors:
 - 1. Duct detectors shall be of photoelectric type.
 - 2. Detectors shall be rated for air velocity to be expected.
 - 3. It shall be possible to alarm duct detector by using remote or local test switch.
 - 4. It shall be possible to clean sampling tubes by access through duct housings front cover.

5. Provide relays adjacent to motor controller, and remote keyed test switch and alarm LED indicator.
 6. In mechanical rooms, alarm LED indicators shall be grouped on a stainless steel cover plate.
 - a. Mount adjacent to main mechanical room door.
 - b. Each LED shall be labeled with detectors loop and address.
 - c. Floor plan of room showing detectors and addresses shall be located adjacent to cover plate.
 - d. Provide Plexiglas cover over plan.
- I. Manual Stations
1. Manual stations:
 - a. **[Single action] [Double action]**
 - b. Constructed of high impact, red Lexan with raised white lettering and smooth high gloss finish
 - c. Contain circuits that communicate station's status (alarm, normal) to Control Panel over two wires
 - d. Mechanically latch upon operation and remain so until manually reset. Stations that use Allen wrenches or special tools to reset shall not be accepted.
 - e. Fitted with screw terminals for field wire attachment
 2. Address shall be field programmable on station.
- J. Interface Modules - General
1. Interface Modules:
 - a. Receive 24 VDC power from separate two wire circuit
 - b. Available in either Class B or Class A supervision version
 - c. Supervised and identified by Control Panel
 - d. Capable of being programmed for its "address" location
 - e. Compatible with addressable manual stations and intelligent detectors on same intelligent initiating circuit
 2. Class A wiring shall be looped back and connected to module.
 3. Class B wiring shall be supervised by an end-of-line device.
 4. Should interface module become non-operational or removed, trouble signal shall be transmitted to Control Panel.
 5. Interface module LED's shall be clearly visible on the face of the trim plate.
- K. Interface Modules - Supervised Control
1. Interface Modules shall be used for control of indicating appliances, door holders, and AHU systems.
 2. For signals, speakers, fire fighter phone jacks and other device control interface module shall provide double-pole/double-throw relay switching that can connect any of the following through 2 amp fuses:
 - a. Zone of signals to power source
 - b. Speakers to audio source
 - c. Fire fighter phone jacks to communications channel
 - d. Variety of controlled devices to appropriate controlling circuits.
 3. Interface modules:
 - a. Communicate supervised wiring status (normal, trouble) to fire alarm control panel.
 - b. Receive from fire alarm control panel command to transfer relay.
- L. Interface Modules - Supervised Monitoring
1. Interface Modules:
 - a. Suited for monitoring of water-flow, valve tamper, and non-intelligent detectors.

- b. Addressable interface module shall be provided for interfacing normally open direct-contact devices to an intelligent initiating circuit.
 - c. Provide power to and monitor status of zone consisting of conventional 2-wire smoke or heat detectors and N/O contact devices.
 - d. Communicate zone's status (normal, alarm, trouble) to Control Panel.
2. Supervision of zone wiring shall be Class B or Class A.
- M. Interface Modules - Non-Supervised Control
1. Interface module shall provide double-pole/double-throw relay switching for loads up to 120VAC. It shall contain 2 amp fuses, one on each common leg of relay.

2.021 SPEAKER/STROBE DEVICES

- A. Combination Speaker/Strobe Devices
1. Speakers:
 - a. Operate on 24 V DC circuit
 - b. Include separate wire leads for in/out wiring for each leg of associated signal circuit. Tappings of signal device conductors shall not be acceptable.
 - c. Be suitable for rear mounting behind audio-visual assemblies, which shall be flush or semi-flush mounted, with manufacturer back boxes and flush trim ring.
 - d. Have field adjustable output taps, 3 taps minimum.
 - e. Provide minimum sound pressure level of 85.7 dBA at 10' using 1-watt tap.
 - f. Speakers located in mechanical rooms shall have 3 taps minimum with 8W being the highest.
 - g. Provide a minimum sound pressure level of 90 dBA at 10' using the 2-watt tap.
 - h. Include a blocking capacitor for line supervision and screw terminal for in-out wiring.
 2. Strobes shall be:
 - a. Multi-tap units with taps at 15, 30, 75, and 110 cd.
 - b. Tapped at 15-candela peak power or as noted on drawings.
 - c. Have flash synchronization module on circuit when more than one strobe is visible at a time.
 - d. On separate supervised circuit from speaker circuit.
 3. White Lexan lens shall have "FIRE" in red lettering visible from a 180° field of view.
 4. Have off-white semi flush housing.
 5. Strobe circuit loading shall be calculated at 75 cd tap for all devices, except in mechanical, interstitial spaces where circuit loading shall be calculated at 110 cd tap
- B. Speaker Devices
1. Speakers without strobe units:
 - a. Include above-listed features
 - b. Flush ceiling mounted **[white] [XXX]** baffle and recessed back box for installation in suspended ceiling system.
 - c. Red baffle with surface mounted back box, furnished by speaker manufacturer, where installed in areas with exposed structure.
 - d. Cast metal grille and back box where installed in mechanical/interstitial spaces.

2.022 CONVENTIONAL PERIPHERAL DEVICES

- A. Sprinkler Waterflow Switches - Wet Systems
1. To be furnished and installed by Fire Protection Contractor under Division 21.
 2. To prevent false alarms, flow switch shall incorporate adjustable time delay mechanism between the paddle-operated stem and alarm initiating contacts.
 3. Tapped 1/2" conduit connection
- B. Sprinkler Valve Tamper Switches - Wet Systems

1. Sprinkler valve tamper switches shall be furnished and installed by Fire Protection Contractor under Division 21.
2. Switch shall be provided with either 1 or 2 sets of S.P.D.T. micro switches as required.
- C. Door Holders
 1. Magnetic door holders:
 - a. Provided by the General Contractor. Refer to Section **[08 7110 - Door Hardware]**.
 - b. Capable of being surface, flush, or semi-flush mounted as required
 2. Power for door holders shall be 24 V.
- D. Fault Isolator Module
 1. Provide Fault Isolator Module (FIM) on initiating device circuits in following situations:
 - a. Loop extends to another floor
 - b. Loop extends to another building
 - c. For each 25 devices on a loop
 2. Fault Isolator Module shall:
 - a. Automatically re-connect isolated section of loop upon correction of fault conditions.
 - b. Not require any address setting
 - c. Operations shall be totally automatic. It shall not be necessary to replace or reset FIM after its normal operation.
 - d. Include LED, which shall flash under normal operation and illuminate steady to indicate short circuit.

2.023 ISOLATED LOOP CIRCUIT PROTECTORS (ILCP)

- A. Fire Alarm Control Panel shall include Isolated Loop Circuit Protector (ILCP) on circuits which extend beyond building. Circuits include, initiating device circuits, alarm notification appliance circuits, and signaling line circuits.
- B. ILCP shall:
 1. Be located as close as practical to point where circuits leave or enter building.
 2. Have line-to-line response time of less than 1 nanosecond.
 3. Have #12 AWG grounding conductor with maximum length of 25'. It shall be run in straight line and connected to building grounding electrode system.
- C. Spark gap devices or devices incorporated in or installed within control panel in lieu of ILCP are not acceptable.

PART 3 - EXECUTION

3.01 GENERAL

- A. Class B circuiting shall be used.
- B. Installation shall be done in neat, workmanlike manner in accordance with manufacturer's recommendations.
- C. Smoke detectors shall not be mounted until construction is completed.

3.02 RACEWAYS

- A. Fire Alarm Panel risers shall be in conduit system separate from other building wiring.
- B. Wiring shall be in conduit system separate from other building wiring. See Section 26 0533 - Raceway and Boxes for Electrical Systems.
- C. Minimum 3/4" steel raceway.
- D. Contractor shall size conduit and boxes by circular mil size of cable in conduit or box.
- E. Surface access to existing alarm initiating circuits in public areas shall be via surface metal raceways (minimum equivalent to 3/4" conduit) and box extensions.
- F. Existing conduit and surface metal raceway that are not 3/4" size may be reused if found to have adequate space for existing and new conductors.

3.03 CONDUCTORS

- A. Cables and wires shall be provided per manufacturer shop drawings.
- B. Conductors shall be color-coded. Coding shall be consistent through out facility.
- C. Green wire shall be used only for equipment ground.
- D. Control Panel power wiring shall be #12 AWG.
- E. Control Panel shall have #12 AWG equipment ground wire.
- F. Where fire alarm circuits enter or leave building, additional transient 75 to 90 V gas tube protection shall be provided for each conductor.
- G. Cable Detector Loops shall be twisted pair with shield jacket. Shield shall be connected to earth ground only at control panel.
- H. Detector wiring shall not be in same conduit with 120/240 VAC wiring or other high current circuits.
- I. T-taps or branch circuit connections allowed for class B intelligent loop circuits.
- J. Leave 8" wire tails at each device box and 36" wire tails at Control Panel and Remote Annunciator Panel.
- K. Cable for RS 485 devices (Remote Annunciators) shall be shielded-twisted pair for data signal.
- L. Wiring of initiating device circuits, alarm horn circuits, and alarm strobe circuits shall be #14 AWG minimum.
- M. Fire alarm cable shall be held in place at device box by means of 2-screw connector, (do not use squeeze or crimp type connectors).
- N. Splices or connections shall be made within approved junction boxes and with approved fittings.
- O. Boxes shall be red and labeled "FIRE ALARM SYSTEM" by decal or other approved markings.
- P. Horn and strobe circuits shall have separate conductors, and shall operate independently of each other.
- Q. Tray cable is not acceptable for use as fire alarm systems raceway.

3.04 DEVICE MOUNTING

- A. Recommended mounting heights, and requirements are as follows:
 - 1. Fire Alarm Control Panels
 - a. Mount control panel so visual indicators and controls at 60" above floor level.
 - 2. Remote Annunciators
 - a. Mount panel so visual indicators and controls at 60" above floor level.
 - b. Install multi-gang box as required by manufacturer, flush or surface mounted.
 - 3. Audio-Visual Devices
 - a. Install flush, semi-flush [**or surface mount**] 6" below finished ceiling or 80" from bottom of device to finished floor.
 - b. No devices protruding 4" or more shall be installed lower than 80".
 - c. Audio/visual devices may be installed on the ceilings in accordance with NFPA 72 - Table 2-A.
 - d. For surface mounting, use manufacture-supplied backboxes and trim plates.
 - e. Mark each device with its circuit number.
 - 4. Manual Stations
 - a. Operable part of manual stations shall be installed not less than 3-1/2' (42") and not more than 4-1/2' (54") above finished floor.
 - b. Manual stations shall be in unobstructed locations.
 - c. For surface mounting, use manufacturers supplied backboxes and trim plates
 - d. Mark unit's address on inside and outside of housing.
 - 5. Heat and Smoke Detectors
 - a. Location of detectors shown on plans is schematic only. Detectors must be located according to code requirements.

- b. Surface mounted detectors shall be installed using back boxes equal to base size. Standard octagon and square boxes are not acceptable.
- c. Detectors shall be located on the highest part of smooth ceiling so that edge of detector is no closer than 4" from sidewall.
- d. Ceilings with beams, joists or soffits that exceed 8" in depth require special planning and closer spacing.
- e. Mount detectors on sidewalls with top of detector no closer than 4" from ceiling and no further away than 12".
- f. Smoke detectors shall not be installed closer than 3' from air supply diffusers.
- g. No detectors shall be installed in direct airflow.
- h. Heat and smoke detectors should be located near center of open area, which they protect.
- i. Mark zone number and ranking of each detector on its base.
- j. For intelligent systems, mark address and loop number on each detector's base.

3.05 IDENTIFICATION LABELS

- A. Junction boxes shall be painted red and labeled "Fire Alarm."
- B. Circuits must be labeled with name of circuit and area being served by circuit.
- C. Labels shall be permanent, and be machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS SHALL BE ALLOWED.
- D. Labels shall be self-laminating, white/transparent vinyl and be wrapped around cable **[sheath]**.
- E. Flag type labels are not allowed.
- F. Labels shall be of adequate size to accommodate circumference of cable being labeled and properly self-laminate over full extent of printed area of label.
- G. Adhesive type labels not permitted except for phase and wire identification.
- H. Wiring color code shall be maintained throughout installation.
- I. Green wire shall be used only for equipment ground.

3.06 MANUFACTURER'S SERVICES

- A. Supervision of installation shall be provided by trained service technician from manufacturer of fire alarm equipment.
- B. Technician shall be US certified and have had minimum of 2 yrs of service experience in fire alarm industry.
- C. Technician's name shall appear on equipment submittals, and letter of certification from fire alarm manufacturer shall be sent to project engineer.
- D. Manufacturer's service technician shall be responsible for following items:
 - 1. Pre-installation visit to job site to review equipment submittals and verify method by which system shall be wired.
 - 2. Make periodic job site visits to verify installation and wiring of system.
 - 3. Upon completion of wiring, final connections shall be made under supervision of technician.
 - 4. At time of final checkout, technician shall give operational instructions to Owner and/or his representative.
 - 5. Job site visits shall be dated and documented in writing and signed by Electrical contractor.
 - 6. Discrepancy shall be noted on document and copy kept in system job folder, which shall be available to project Engineer any time during project.

3.07 TESTING

- A. Manufacturer's authorized representative shall perform complete functional test of each system and submit written report to Contractor attesting to proper operation of completed system prior to final inspection.
- B. Contractor shall test each device in system before system is considered substantially complete.

- C. Completed fire alarm system shall be fully tested by Contractor in presence of Owner's representative and local Fire Marshal.
- D. Upon completion of successful test, Contractor shall:
 - 1. Certify system to Owner in writing
 - 2. Complete NFPA 1-7.2.1 record of completion form
 - 3. Provide as-builts and O&M manuals

3.08 WARRANTY

- A. Warrant completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of 2 yrs from the date of substantial completion of project.
- B. Post warranty period along with company's name and telephone number inside fire alarm panel.
- C. Warranty service for equipment shall be provided by system supplier's factory trained representative.
- D. Warranty shall include parts, labor, and necessary travel.
- E. Occupied facility shall not be without UL and NFPA approved and fully operational fire alarm system for period longer than 2 h. Emergency response shall be provided within 2 h of notification, to contractor, of failure of system to perform operationally per UL and NFPA standards.
- F. Non-emergency service calls shall be responded to within 24 h of notification to contractor.
- G. Repairs and/or replacement shall be completed within 72 h of time of notification. Other than emergency, actual repairs and/or replacement shall be provided during normal working hours, Monday through Friday, excluding holidays.
- H. If repair and/or replacement cannot be made within prescribed time, other means and methods of protection shall be provided to insure safety of building occupants during which time system is not in compliance with standards. This may involve up to and include hiring Owner approved qualified personnel to stand fire watch, at contractor's expense.

3.09 TRAINING

- A. Contractor shall provide minimum of 4 h system operation training for Owner, Architect/Engineer, and fire department personnel.
- B. Training session shall be at a time to be stipulated by Owner.
- C. Training shall be completed prior to final inspection.

3.010 MAINTENANCE CONTRACT

- A. Equipment manufacturer shall make available to Owner, maintenance contract proposal to provide minimum of 2 inspections and tests per year in compliance with NFPA-72 Codes.

3.011 SPECIAL CONSIDERATIONS

- A. Contractor shall refer to Division 01, General Requirements, item **[INSERT NUMBER]** "SPECIAL SITE CONDITIONS."
- B. Contractor shall notify Owner's security officer 24 h in advance of any zones inoperative for a period of time exceeding 2 h.
- C. Existing fire alarm systems must be returned to full operation at end of each working day, or notification to campus security of what zones are inoperative on a daily basis in writing, hand delivered.

END OF SECTION